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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN No. 3.

B. T. GALLOWAY, Chief of Bureau.

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MACARONI WHEATS.

BY

MARK ALFRED CARLETON,
CEREALIST, VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.

Issued December 23, 1901.

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B. T. GALLOWAY, Chief of Bureau.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., July 31, 1901.

Sir: I have the honor to transmit herewith the manuscript of a paper on Macaroni Wheats, by Mark Alfred Carleton, Cerealist, Vegetable Pathological and Physiological Investigations, this Bureau, and recommend its publication as Bulletin No. 3 of the Bureau series.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

The following bulletin by M. A. Carleton, Cerealist of this Office, treats of the macaroni wheats, with special reference to their growth without irrigation in the semiarid regions of the United States. Some of the best varieties of macaroni wheats have been imported by the Department of Agriculture, and have been tested in these regions with extremely gratifying results. It is believed that with a little care a large industry can be built up in regions of the United States where the ordinary wheats do not succeed. Mr. Carleton has had special advantages for the study of these wheats in Russia and elsewhere, and his bulletin is commended as the latest word on a very interesting and practical subject.

Albert F. Woods.

Office of the Pathologist and Physiologist,
Washington, D. C., August 1, 1901.

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MACARONI WHEATS.

By Mark Alfred Carleton,
Cerealist.

INTRODUCTION.

For more than thirty-five years there have been occasional introductions into this country of the hardy, glassy wheats of the durum group, chiefly from Russia, but also from Algeria and Chile. In Europe they are called simply hard wheats, and correctly so, since the hardest bread wheats of the world are really soft compared with them. In this country they have not until recently been sufficiently well known to receive a special name. Now, however, through the recent introductions and publications of this Department the term macaroni wheat is becoming rapidly adopted, and its application is already pretty well understood.

Heretofore these wheats have been received with but little favor. In spite of their excellent yields and hardiness the lack of a market made their establishment a practical impossibility for the time. Our own macaroni factories were using ordinary bread wheats and the attention of foreign factories had not been called to the possibility of securing excellent durum wheat from this country. Our millers refused to receive such wheat, not being able to utilize it with their present methods of milling for bread flour only. Elevator men also refused to handle it, as it would spoil the sale of other standard wheats if mixed with them in the elevators. Also the different varieties introduced had not been tested sufficiently long to obtain a just idea of their value, and were often grown in localities to which they were entirely unadapted. Thus a combination of unfortunate circumstances gave to these wheats a reputation not at all deserved. Only two years ago a writer severely criticised the Department for introducing a consignment of Kubanka wheat, saying that the variety was already considered to be a failure in this country.

Now, however, as a result of the efforts of the Department begun two years ago to establish these durum wheats, there is being manifested a great change of opinion as to their merits, in view of their probable complete utilization in the future for the manufacture of macaroni. The following are some of the reasons for this change in opinion: (1) Certain European manufacturers are ready at any time to contract for large amounts of American grown wheats of this kind so long as they stand the proper test. (2) Samples already sent to European experts for examination have given very favorable results in comparison with foreign samples, though it is almost certain that the samples sent were in quality below the average of what can be produced and is being produced in this country. (3) Quite a number of American factories are showing a disposition to use semolina[1] made from these wheats just as soon as they can obtain a sufficient amount of it. (4) Several American flour mills are now grinding macaroni wheat. (5) From a rough calculation, probably 75,000 to 100,000 bushels of macaroni wheat will be harvested in the Great Plains States in the season of 1901. (6) From the standpoint of results as a cultivated crop numerous careful experiments have absolutely proved the success of these wheats in the Great Plains. (7) Excellent bread as well as macaroni can be made and is being made in large quantities (e. g., in the Volga River region of Russia) from these wheats. In the light of such facts one is forced to believe that there is before us the possibility of establishing practically a new wheat industry of great magnitude.

CHARACTERISTICS OF MACARONI WHEATS.

Macaroni wheats proper belong in the durum group, known by the botanical name of *Triticum durum*. In France they are called *Blé dur;* in Germany, *Hartweizen;* and in Spain, *Trigo duro*. They are also sometimes called barley wheats, or *Gerstenweizen*, because of their resemblance to barley. The wheats of this group grow rather tall and have stems that are either pithy within or hollow, with an inner wall of pith, or, in a few varieties, simply hollow, as in the ordinary bread wheats. The leaves are usually broad and smooth, but have a peculiar whitish green color and possess an extremely harsh cuticle. The heads are comparatively slender in most varieties, compactly formed, occasionally very short, and are always bearded with the longest beards known among wheats. The spikelets (meshes) are two to four grained. The outer chaff is prominently and sharply keeled, and the inner chaff somewhat compressed and narrowly arched in the back. The grains are usually very hard and glassy, often translucent, yellowish-white in color, occasionally inclining to reddish, and usually rather large. In certain varieties the grains are almost or fully as large as those of Polish wheat, and are sometimes mistaken for it.

In the field these wheats resemble barley very much, and one seeing them there for the first time and not familiar with their appearance is apt to think of them as being actually barleys. There are many varieties differing in shape and size of head, color, and amount of hairiness of chaff, color of beards, etc. (See Plates I and II.) Besides their exceptional fitness for the manufacture of macaroni and other edible pastes, these wheats possess for the grower two other admirable qualities to a

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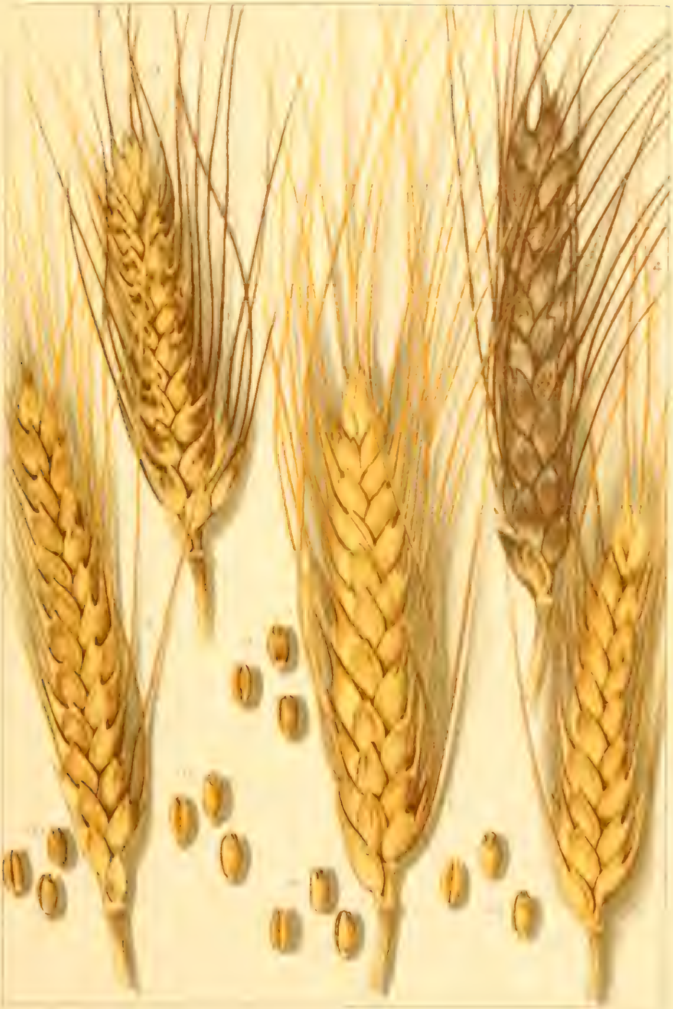
[1] The special name of the milled product as used by the macaroni manufacturer.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greater degree than ordinary wheats. They are extremely resistant to drought and to attacks of most fungous pests. Black stem rust, however, sometimes affects them badly. They do not stool extensively. Durum wheats are particularly sensitive to changes of environment and quickly deteriorate when grown in a soil or climate to which they are not adapted. A sufficient change of conditions to effect such a result may be found even within the distance of a few miles. For example, it is well understood in south Russia that the excellent variety Arnautka gives the best results only when grown within a limited area bordering the Azov Sea. So also the best Kubanka is found east of the Volga on the Siberian border. In the Caucasus this variety apparently has actually developed into a red winter wheat, though the original is a yellowish-white spring wheat.

Macaroni wheats are adapted to soils rich in nitrogenous matter but considerably alkaline, and they invariably give the best results in a hot, dry climate. Almost all the varieties are best adapted for spring sowing. The young plants are always light green in color, and even when sown in the autumn grow at once erect and very rapidly, thus being poorly prepared to survive a severe winter. Where the winters are mild, however, as they are south of the thirty-fifth parallel in this country, they may be grown as winter wheats,[1] and in such cases the large amount of autumn growth made allows them to furnish excellent fall pasturage.

Polish wheats produce a grain very similar in nature to that of the durum wheats, and are also often used for making various pastes. These are varieties of *Triticum polonicum*. (See Pl. II, *1*.) The plants are tall, with smooth stems that are more or less pithy within. They stool very sparingly. The heads are extremely large and loosely formed, and before ripening are bluish green in color. A special peculiarity of Polish wheats is the rather long, narrow outer chaff, papery in structure, and standing out slightly from the head instead of being rigid and closely applied to the spikelets, as in other wheats. The grains are of great size when normal, especially quite long, yellowish white in color, and very hard. These wheats also withstand drought and are somewhat resistant to leaf rust.

Varieties of the Poulard group of wheats (*Triticum turgidum*) are also occasionally used for macaroni, but are comparatively of minor importance in this regard. The use of common bread wheats for making macaroni will be referred to in other places.

DISTRIBUTION OF MACARONI WHEATS.

Macaroni wheats stand foremost among all wheat groups in their excellent adaptation to regions of intense heat and drought. In addition, however, they require for their most successful cultivation a soil rich in humus and containing a good proportion of potash, phosphates, and lime. Where these wheats succeed best the soil is always found to be considerably alkaline. Naturally, therefore, they are grown to the greatest extent in east and south Russia, Turkestan, North Africa, and the drier portions of Argentina, Chile, India, and Asia Minor. They are also grown in Spain, Italy, Greece, Roumania, Mexico, and the Central American States.

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[1] Results of recent experiments show that they will succeed as winter wheats even in parts of Kansas.

By far the largest production of macaroni wheats is in east and south Russia, a large part of which finds a ready market for macaroni making in the cities of southern France and Italy. Ten or more rather distinct varieties are grown in Russia. These are much mixed in shipping, and are often exported under the one name of Taganrog wheat simply because they are so commonly shipped from the port of that name. There is no special variety correctly called Taganrog, but that name is usually applied to any variety whatever of Russian durum wheat after it leaves Russia.

Unfortunately in making up statistics of wheat production no distinction is made of macaroni wheats, so that it is impossible to give accurately the distribution of these wheats in Russia. In a general way, however, the governments in which these wheats are chiefly grown are as follows: Orenburg, Samara, Turghai Territory, Uralsk Territory, Saratov, Don Territory, Astrakhan, and portions of Kuban Territory, Daghestan, Stavropol, and Taurida. In the Turghai and Uralsk Territories and Astrakhan certainly the larger proportion of the entire wheat production is of these wheats, it being practically impossible to grow ordinary wheats in certain districts because of the extremely low rainfall. The farmers are, many of them, Kirghiz, who have given up nomadic habits and have adopted a settled mode of life. The chief varieties grown are Kubanka and Beloturka. The greater part of the macaroni wheat of south Russia is grown in the region bordering the Azov Sea. Here there are several varieties grown, the principal one being Gharnovka (Pl. III). In portions of Turkestan the climate is very favorable for durum wheats, because of its great aridity. One variety especially, Sarui-bugda (Pl. IV, *3*), apparently the principal durum wheat grown in Turkestan, has attained an excellent reputation in southeast Russia. Algeria produces macaroni wheats almost exclusively. As the average annual wheat production of that country during the years 1895–1900 was 23,785,167 bushels,[1] the comparative amount of these wheats grown there is therefore rather large. There are many varieties. Some macaroni wheat is also produced in Egypt and Tunis, but a large portion of Egyptian wheat is of the Poulard group (*Triticum turgidum*). Almost all Spanish varieties are of the durum group, but the entire

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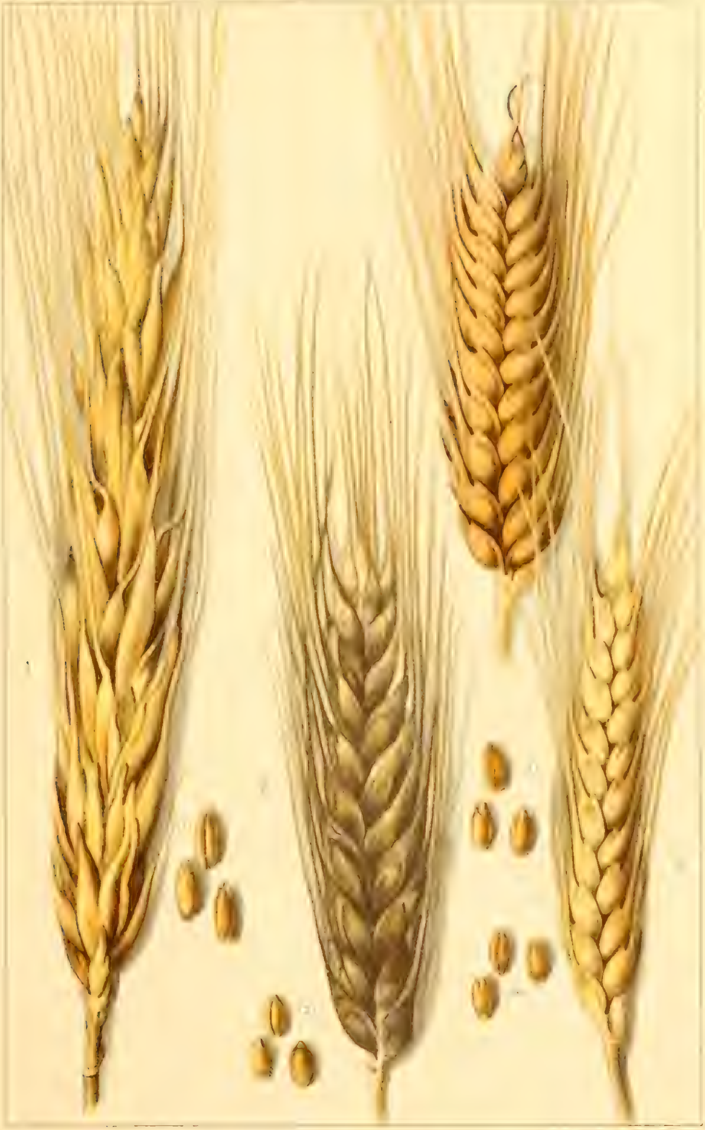
[1] Statistics furnished by the Statistician of the Department of Agriculture.



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wheat production of Spain is comparatively small. In Greece, Mexico, and Central America—particularly in Nicaragua—these durum varieties are also almost exclusively grown.

ADAPTABILITY OF DURUM WHEATS TO OUR SEMIARID DISTRICTS.

The nature of the climate and soil of the regions where macaroni wheats are already grown in quantity and most successfully, would indicate that these wheats are admirably adapted to the conditions of our own semiarid districts. That this is true is pretty well proved both in theory and by experiment. Conditions of heat and drought, richness of soil, alkalinity, etc., exactly similar to those that prevail in east Russia and North Africa, exist in the more arid portions of our Great Plains, except that in the former regions these conditions are a little more extreme as a rule. As the best macaroni wheats are grown most successfully in east Russia, it will be desirable to compare the climatic conditions of that region with corresponding portions of the Great Plains, that we may note more closely the degree of similarity in this regard.

CLIMATIC COMPARISONS.

The macaroni wheat district of east Russia comprises in a general way the Volga River region from about the latitude of Kazan to the Caspian Sea, but extending eastward to the Siberian boundary and even beyond into the Kirghiz Steppes. The entire district is at least semiarid, and some portions of it seem to be, more properly, arid. The degree of aridity increases to the east and south, the reverse of the conditions in this respect in our Great Plains, where the degree of aridity increases to the west. Near the Siberian border begins the Kirghiz Steppes of western Siberia, a monotonous, unbroken expanse of treeless arid plains, with a rainfall reaching less than 10 inches, but nearly all of which falls in the growing season. Sages, feather grasses (Stipa), salt bushes, etc, make up a large part of the native vegetation. The dry heat of midsummer is so intense that mirages are frequent. The rich black earth is dry, strongly alkaline, and powdery, but absorbs greedily the rain that does fall. Evaporation goes on rapidly, and well-adapted plants are provided with means of resisting evaporation. (See Pl. V.)

The particular climatic features which characterize a region of this sort, and which distinguish it from ordinary agricultural districts so far as macaroni wheats are concerned, are as follows: (1) The very low average annual rainfall; (2) the very large proportion of this rainfall which occurs during the growing season; (3) the character of this precipitation, occurring in the form of quick thunder storms, with very little fog or mist; (4) the prevailing clearness and dryness of the atmosphere, and (5) the great extremes of temperature, especially intense summer heat.

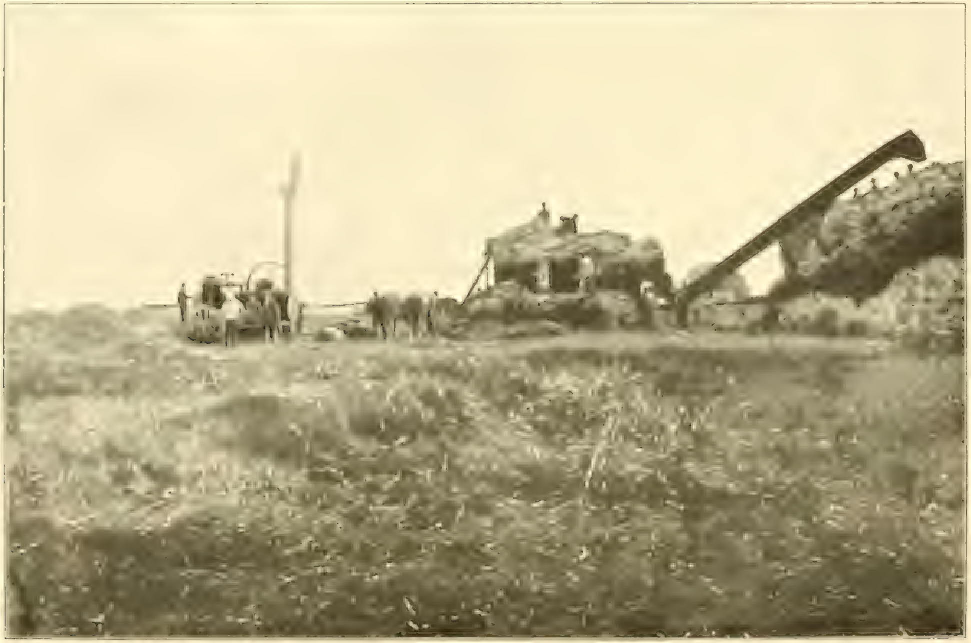
The following table will illustrate some of these features. In this table are given the normal mean temperatures for January, July, and the year, and the normal rainfall for the year and for the growing season (May to September, inclusive) as taken at ten meteorological stations representing as fairly as possible the durum wheat districts of east and south Russia, and also similar data for nine stations corresponding to these in our Great Plains. For contrast with humid areas similar data are also given for three stations—Eastport, Oswego, and Lynchburg—in the eastern United States.

Table I.—*Temperature and rainfall in several localities in Russia and in the United States.*[1]

	Normal mean January temperature.		Normal mean July temperature.		Normal mean yearly temperature.		Normal total rainfall, growing season.		Normal annual rainfall.	
	°C.	°F.	°C.	°F.	°C.	°F.	*Mm.*	*In.*	*Mm.*	*In.*
Kazan	−13.7	7.1	19.5	67.1	2.9	37.2	261.9	10.3	387.6	15.2
Ufa	−13.5	7.6	20.8	69.4	3.0	37.5	278.0	10.9	421.8	16.6
Simbirsk	−12.9	8.7	20.6	69.0	3.3	37.9	256.6	10.1	408.4	16.0
Samara	−12.7	9.0	21.3	70.3	4.1	39.3	251.1	9.8	396.4	15.6
Orenburg	−15.2	4.5	21.6	70.9	3.2	37.8	201.9	7.9	395.3	15.5
Orsk							146.6	5.7	270.1	10.6
Saratov	−10.1	13.7	21.7	71.0	5.4	41.7	191.9	7.5	423.1	16.6
Sarepta	−10.5	12.9	23.9	75.0	7.4	45.4				
Kerch	.8	33.4	23.9	75.1	11.5	52.7	206.0	8.1	383.8	15.1
Taganrog	− 6.6	20.0	21.5	70.8	7.6	45.7	265.3	10.4	565.6	22.2
Eastport	− 6.4	20.4	15.7	60.4	5.2	41.5	451.6	17.7	1147.5	45.1
Oswego	− 4.2	24.3	20.5	69.0	8.0	46.4	375.6	14.7	889.5	35.0
Lynchburg	2.6	36.8	25.2	77.5	13.8	56.9	492.7	19.4	1094.7	43.1
Moorhead	−18.2	− .9	19.7	67.6	3.1	37.6	394.7	15.5	603.7	23.7
Bismarck	−15.2	4.5	20.8	69.5	4.2	39.6	292.1	11.5	469.9	18.5
Huron	−13.8	7.0	21.5	70.9	5.8	42.5	346.7	13.6	534.1	21.0
Yankton	− 9.8	14.2	23.1	73.6	7.6	45.8	436.8	17.2	655.3	25.8
North Platte	− 6.6	20.0	23.0	73.5	8.8	47.9	325.1	12.8	459.7	18.1
Valentine	− 8.3	16.9	22.9	73.3	7.9	46.3	299.7	11.8	486.4	19.1
Concordia	− 4.8	23.2	25.0	77.1	11.2	52.2	433.3	17.0	647.4	25.4
Dodge City	− 3.0	26.6	25.3	77.6	11.7	53.2	347.9	13.7	502.9	19.8
Abilene (Tex)	6.0	42.8	28.1	82.7	17.4	63.4	348.4	13.7	629.6	24.7

[1] The figures in this table are averages of many years' observations and are given by the following authorities: Wild, Die Temperaturverhältnisse des Russischen Reiches, Tabellen, S. LXXII–CCXL, and Die Regenverhältnisse des Russischen Reiches, S. 12–28; Kaiserl. Akad. der Wissensch. St. Petersburg, 1881 and 1887. Klossovski, Klimat Odessui (Russian); Meteorological Observatory of the Imperial New Russian University, Odessa, 1893. Moore, Report of the Chief of the Weather Bureau, U. S. Department of Agriculture, for 1896–97, Washington, D. C., 1897.

A study of the figures in the different columns for the stations in east Russia is very interesting. Great extremes of heat in one are offset by just as great extremes of cold in another. Moreover, at the northern stations the July extremes are still very high, though the yearly mean is normally very low. The small amount of *yearly* rainfall is offset by a proportionately heavy rainfall for the *growing season.* The latter will partially account for the fact that a crop can be grown at all in a district of such low annual rainfall. The contrast between



THRASHING GHARNOVKA WHEAT BY STEAM ON THE ESTATE OF MR. MIKHALKOV AT AMBROCIEVKA IN DON TERRITORY

the figures for this district and those for the three places in the humid area of the eastern United States is very striking. While the January and mean yearly temperatures at Samara and Orenburg, Russia, are much lower than those at Oswego and Eastport, on the other hand the July temperatures at the former places are higher than those at the latter. The January and July extremes at Orenburg and Sarepta are remarkable. Orenburg, with a January normal extremely low and an annual mean normally nearly 5 lower than Oswego, yet possesses a July normal over 1½ higher. The January normal at Lynchburg is above freezing and the normal yearly mean over 6 higher than at Sarepta (see Pl. V), Russia, yet the latter point with a January normal 10½ below freezing lacks but a little over 1 of being as hot in July as Lynchburg. The anomalies of rainfall are fully as striking. At no point in the Russian region does the mean yearly rainfall reach 17 inches, while at Oswego it is over twice that amount and at Eastport and Lynchburg over two and one-half times that amount. But one-half to five-eighths of the total yearly rainfall in the Russian region occurs during the growing months (May to September, inclusive), while in the humid area of the United States considerably less than one-half falls in the growing season. The conditions at Kazan, Ufa, and Simbirsk are particularly interesting. At these points, although the yearly mean is only 16 or 17 inches, the amount falling in the growing season is about five-eighths of that amount. As the nature of the soil in prairie regions enables it to retain an unusually large proportion of the rainfall, it results that the actual amount of water available for plant growth in this semiarid area during the growing season is more than in humid areas where the yearly rainfall is two to three times as great. The lowest rainfall of this region occurs on the borders of the Kirghiz Steppes and near the Caspian Sea. At Orsk, for example, the yearly rainfall is but 10.6 inches and the mean for the growing season is 5.7 inches. But even there the actual amount of water directly available to the plants from May to September is probably nearly as large as at Oswego. In the Orsk district a considerable quantity of excellent macaroni wheat is grown.

The climatic conditions of our northern and central Great Plains region are remarkably similar to those of the region just described, except only that conditions in the former region are in general considerably less severe than in the latter. At no point as far west as the one hundredth meridian is the mean annual rainfall less than 18 inches in the Great Plains region, while, as above stated, the amount falling in the similar Russian region is nowhere more than 17 inches. At three points in the Great Plains region, viz, Bismarck, North Platte, and Dodge City, all near the one hundredth meridian, the yearly mean is normally over 18 inches, the average for the three points being 18.8 inches. The average of the normal means of the points in the Russian region, even excluding the very low figures for Orsk, is 15.9. In other words, *the normal yearly rainfall of the Great Plains at the one hundredth meridian, where wheat growing is at present practically nonexistent on account of the lack of drought-resistant varieties, is nearly three inches greater than that for the entire semiarid Volga region, which is one of the principal wheat regions of Russia, and which produces the finest macaroni wheat in the world.*

A comparison of the normal temperatures of the two regions shows the same sort of similarity, with extremes a little more severe in the Russian region. Points in the Volga region having correspondingly low winter and annual mean temperatures, always show a July temperature a little higher than those of the Great Plains region. At Orenburg, Samara, and Ufa the July temperatures are especially surprising, considering the very low winter temperatures. At Huron, Bismarck, and Moorhead are the best examples, probably, of temperature extremes in the Great Plains, but the extremes are not quite so great as at the three Russian stations.

The humidity of the air is a feature of climate often entirely overlooked, but it nevertheless has a remarkable influence upon plant growth. In the relations of climate to the development and maturity of the wheat grain there are many things not yet thoroughly understood, but the degree of humidity is known to be of the utmost importance. The exact manner in which the influence of humidity is effective—the actual changes in the plant which take place by virtue of its presence or absence—is yet to be investigated in detail, but that there is such an influence seems positive. Its effect upon the wheat plant is in general unfavorable if long continued, and particularly if it occurs near the time of ripening. Great humidity retards maturity, interferes with the production of proteids in the grain, and thereby indirectly softens it and through an overproduction of starch gives it a whiter color, weakens the straw, and presents conditions favorable for the attacks of various fungous pests. It is not so much the great precipitation that causes an inferior quality of grain in the humid areas, but the prevailing humidity of the air and lack of sunshine. Indeed, as already stated, the actual rainfall during the growing season may be nearly or quite as much in the semiarid areas as in the humid areas. Edmond Gain has stated the law in regard to this matter, viz, that "ripening is promoted in a dry air and a humid soil, but is retarded in a humid air and a dry soil."[1] It is pretty generally admitted in regard to many crops that the quality of the fruits or grains is, in some respects at least, injured by excessive humidity. It is especially true, however, of those crops which are characterized by a large proportion of protein or sugar in the fruits or grains, and in the case of durum wheats humidity is so injurious that semiarid conditions are absolutely necessary for the best results in growing them. So long

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[1] Influence de l'humidite sur la végétation. Compt. Rend. 115: 890. 1892.

Sarui bugda in Comparison with other Varieties in Comparative Field Experiments at the Maryland Experiment Station

as the soil is of the right kind, therefore, the conditions in our semiarid plains, even near the one hundredth meridian, are not only none too arid for such wheats, but are the conditions that are *actually necessary* for their successful cultivation.

In Table II are given the absolute and relative humidity for six localities in east Russia and two localities in the Crimea, in comparison with similar data for the localities of the Great Plains, already discussed, and, in contrast with the two series, similar data for the same three places in the humid area already mentioned. The absolute humidity is given not as actual moisture content, but in the form of vapor pressure, being reckoned like barometric pressure, and is stated in both millimeters and inches. The average total number of clear days in June, July, and August is also given for as many of the localities as possible.

TABLE II.—*Absolute and relative humidity for the growing season and for the year, and the average total number of clear days in June, July, and August.*[1]

[illegible]	May.			June.			July.			August.			September.			Year.			
	Absolute humidity.		Relative humidity.	Absolute humidity.		Relative humidity.	Absolute humidity.		Relative humidity.	Absolute humidity.		Relative humidity.	Absolute humidity.		Relative humidity.	Absolute humidity.		Relative humidity.	
	Mm.	*In.*		*Mm.*	*In.*		*Mm.*	*In.*		*Mm.*	*In.*		*Mm.*	*In.*		*Mm.*	*In.*		
Kazan	7.1	0.279	61	9.6	0.377	60	11.7	0.460	67	10.5	0.413	72	7.3	0.287	76	5.6	0.220	77	....
Orenburg	7.3	.287	58	9.5	.374	57	11.6	.456	64	10.5	.413	64	7.3	.287	68	5.6	.220	75	....
Simbirsk	7.6	.299	61	9.9	.389	62	11.6	.456	62	10.2	.401	70	7.2	.283	75	5.6	.220	77	....
[illegible]	7.0	.275	51	11.1	.437	62	13.0	.511	61	11.4	.448	65	8.1	.318	73	(²)	(²)	64	....
[illegible]	7.8	.307	59	9.8	.385	56	11.8	.464	61	10.7	.421	61	8.1	.318	65	6.1	.241	71	....
[illegible]	7.0	.275	50	9.8	.385	54	11.4	.448	53	9.9	.389	53	7.5	.295	59	5.7	.224	70	....
Simferopol	9.5	.374	70	10.9	.429	67	12.0	.472	61	11.7	.460	61	9.5	.374	69	7.4	.291	73	38
Genichisk	10.4	.409	75	12.8	.503	70	14.9	.586	70	13.6	.535	70	10.9	.429	75	8.4	.330	59	28
Eastport	6.1	.241	77	8.3	.330	81	10.4	.410	81	10.6	.420	83	8.9	.353	81	4.9	.194	76	21
[illegible]	[illegible]	[illegible]	[illegible]	11.1	.438	74	12.6	.497	72	12.2	.482	73	9.5	.375	74	5.6	.223	75	28
[illegible]	[illegible]	[illegible]	[illegible]	14.4	.569	71	15.9	.627	72	15.5	.611	75	12.6	.499	78	7.6	.302	71	29
[illegible]	[illegible]	[illegible]	[illegible]	11.1	.437	71	12.8	.504	73	10.8	.427	71	7.8	.311	72	4.0	.159	76	29
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.418	70	12.1	.480	66	10.3	.408	63	7.3	.290	65	4.2	.166	71	30
Huron	6.0	.240	61	11.0	.434	66	12.3	.485	64	10.7	.425	64	7.3	.289	62	4.2	.168	69	33
Yankton[3]	7.0	.278	67	11.8	.468	71	14.0	.555	71	12.4	.492	72	9.1	.359	69	5.1	.201	69	33
Valentine	6.4	.253	61	10.1	.399	66	11.6	.459	64	10.8	.426	64	7.5	.298	62	4.8	.189	67	30
North Platte	6.7	.266	62	10.7	.421	66	12.8	.506	67	11.7	.463	67	8.0	.317	63	4.9	.197	66	32
Concordia	8.3	.327	65	12.8	.506	66	14.7	.581	66	13.7	.540	68	10.1	.400	67	6.1	.242	68	32
Dodge City	8.1	.321	61	11.8	.467	61	13.1	.519	61	12.5	.496	63	9.2	.364	62	5.7	.228	63	38
Abilene, Tex	11.6	.458	64	14.6	.575	63	15.0	.593	58	15.0	.593	64	12.8	.504	67	8.6	.339	65	42

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[1] The data for Russia are obtained from the excellent work of A. Kaminski, "Vertheilung der Feuchtigkeit der Luft Russland," pp. 34-351, St. Petersburg, 1894, and from A. Klossovski's "Contributions to the climatology of Southwest Russia, Odessa, 1899." The data for the United States is taken partly from the Annual Report of the U. S. Weather Bureau, 1896-97, and partly from unpublished reports kindly furnished by that Bureau.

[2] No figures given. All other data for Samara are meager and cover but a few years' time.

[3] Relative humidity calculated from three daily observations instead of two, as in case of the other stations.

From the table it is seen that the humidity for the summer months in the east Russian region is quite low compared with our humid area in the east, but that at the same time it corresponds very well with that of the semiarid plains region. The figures for relative humidity for a number of points in our Great Plains are very low, being all under 70. On account of the close proximity of the Russian point Genichisk to the Azov Sea its summer humidity is considerably greater than it would be otherwise. The district near to Genichisk is really quite dry and produces a good quality of Gharnovka wheat. The most interesting feature concerning humidity is that while the actual *rainfall* of the growing season in the semiarid districts is greater than in the humid area—a fact in itself interesting and most significant, as already pointed out—the *humidity* is as a rule less; that is, the rain of the semiarid districts falls in quick storms, alternating with many hot, clear days, ideal conditions for durum wheats.

The climatic features of these two regions have thus been compared somewhat in detail, since the east Russian region is at present the most important in the production of macaroni wheat and is likely to have as its strongest future rival the very similar northern Great Plains region of this country. But, as before stated, there is also a large production of these wheats in southern Russia, particularly in the region bordering the Azov Sea (see Pl. VI, figs. 1 and 2) in Kherson district and in the extreme North Caucasus. The corresponding districts of this country for which varieties from south Russia should be well adapted are the western portions of Texas, Oklahoma, and Kansas, and eastern Colorado, and perhaps portions of New Mexico, Arizona, and California. In all the south Russian region there are constant droughts and great extremes of temperature, but especially intense summer heat. On the west shore of the Caspian Sea and in the Azov Sea region the heat and drought are particularly severe, these regions being very similar in these respects to western Kansas, western Oklahoma, and the Texas Panhandle. The average rainfall from Dodge City, Kans. to Abilene, Tex., is about the same as from Kerch to Taganrog, as may be seen in the table; but the average temperature of the Azov Sea region is a little lower. In Texas, New Mexico, and Arizona the Algerian varieties will probably be best adapted for trial. In New Mexico and Arizona especially the conditions seem to be particularly suited for Algerian wheats.

COMPARISON OF SOILS.

The macaroni wheat districts of Russia lie in the well-known Chernozem or "black earth" belt, which is almost a perfect counterpart of our Great Plains in depth and richness of soil. The most thorough investigations have been given to the Chernozem soils by Russian geo-botanists, chemists, and agronomists, and many analyses

VOLGA RIVER REGION NEAR SAREPTA

have been made, both chemical and mechanical. Mechanical analyses of a number of soil samples obtained by the writer from that country have also been made by the Bureau of Soils of this Department. All such analyses, in comparison with similiar ones made of the soils of the Great Plains, show a most remarkable similarity.

From a chemical standpoint the soils of the two regions are similarly characterized: (1) By an exceptionally large amount of thoroughly humified organic matter; (2) by the presence of an unusual proportion of phosphates, and (3) by a great amount, comparatively, of lime, potash, and other alkalies. These soils are therefore rich in base-forming metals, and are not acid, while forest soils are distinctly acid. It is well known that the substances thus more abundant in these soils than in others are just those usually needed by the wheat plant. But the indirect influence of the great proportion of lime and humus in so changing the condition of other substances as to cause them to be more easily made use of by the plant is of equal importance. Of course, the amount of soluble mineral salts present may become so great sometimes as to be really injurious to plant growth, forming actual alkaline wastes. But these are found only in certain restricted areas near the borders of salt lakes, and even in the vicinity of these wastes the very best quality of macaroni wheat is sometimes grown.

The mechanical structure of the soils is of the very nature best adapted for giving the plant the benefit of the substances contained, even under adverse conditions of climate. Humus is a great absorbent of water, and the extreme fineness of the soil particles makes it very retentive of moisture. This quality is still further increased by the presence of so much alkali. Such soils therefore retain for the growing plants a much larger proportion of the rain that falls than is possible in humid areas.

A map (fig. 1) shows the portion of the United States in which macaroni wheat may be grown. The district in which these wheats will be most successful is a comparatively narrow belt extending northward and southward through the Great Plains. Of course, the boundaries must be understood to be arbitrary and only approximately correct. One hundred to two hundred miles east of this belt macaroni wheat may give good yields and prove hardy, but the quality of grain will not be what it should. In all wheat area west of this belt the gluten content of the grain will not be so good, because of the lack of nitrogen in the soil.

EXPERIMENTAL PROOF.

After all, the most convincing evidence that a new crop is or is not adapted to the region to which it is introduced must be found in the results of actual trials of the crop in that region. Such evidence, if there is sufficient of it, must be received as final and conclusive. If these results substantiate the conclusions arrived at by a comparison of the features of soil and climate, such as we have given above, it is a gratifying confirmation of the idea that introductions of new crops should proceed upon the basis of a previous scientific investigation of environment.[1]

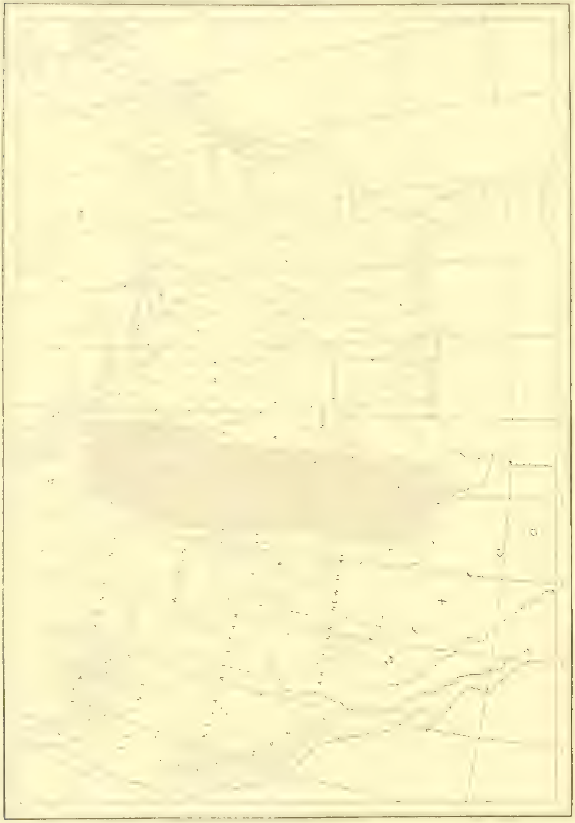

Fig. 1.—Map of the United States showing where macaroni wheat can be grown.

Territory in which macaroni wheat may be grown, but the qu[illegible] gr[illegible]ll not be [illegible]

Territory in which macaroni wheat will succeed best, and without irrigation, s[illegible] 15 inches

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[1] See Russian Cereals Adapted for Cultivation in the United States. Bull. No. 23, Division of Botany, U. S. Dept. of Agriculture, pp. 7–11, paragraph (1). Also the Basis for the Improvement of American Wheats. Bull. No. 24, Division of Vegetable Physiology and Pathology, pp. 7–9, 42 (top of page and note), and 81, paragraph 17.

As already stated, macaroni wheats have been introduced now and then and grown in a very few places for many years, but the growers becoming discouraged by the absence of any demand for the wheat, usually abandoned its culture soon. Nevertheless, the admirable qualities of these varieties—their great yielding power, earliness, drought resistance, and resistance to diseases—have always been noticed and remarked upon.

So far as the writer can determine, Russian macaroni wheat was first introduced into this country in 1864 by this Department. It was of the variety Arnautka and was purchased at Odessa, Russia. It was afterwards distributed annually by the Department for several years and attracted much attention because of its hardiness, early maturity, and yield. In Lincoln County, Ill., it ripened two weeks earlier than other spring wheats. In Dixon County, Nebr., it yielded 30 bushels per acre and ripened four to six days earlier than other varieties. In Minnesota it ripened a week earlier than Scotch Fife and yielded remarkably.[1] At that time, however, the possible use of these wheats for making macaroni was apparently not thought of, and their cultivation did not continue extensively. During the last three years the Department has again taken hold of the matter in a thorough and comprehensive way and with the aim to stimulate as far as possible a market, both domestic and foreign, when they are grown. A number of the very best Russian varieties have been introduced and tested systematically in comparison with standard varieties in cooperation with State Experiment Stations and certain private parties.

That the results of these experiments, both at the stations and by private parties, abundantly prove the adaptability of durum wheats to our semiarid districts is shown by the evidence which follows.

TESTIMONY OF PRIVATE PARTIES.

In Texas a great deal of attention has been given to Nicaragua wheat (Pl. I, 2), a variety of the macaroni wheat group. One of the pioneers in experience with this wheat, formerly a millwright, and afterwards statistical correspondent of this Department, is Mr. James J. M. Smith, of Turnersville, Tex., who has often urged the importance of giving more attention to it. The following extracts from his correspondence with this Department give his testimony concerning this wheat:

> There were thousands of bushels raised here (Burnett, Tex.) as late as seventeen years ago, and a gentleman who hailed from New Orleans bought in this section about 100,000 bushels for shipment to Europe for use in making graham flour and macaroni. This wheat was hardy, and was not attacked by smut or rust, and was a sure crop, averaging from 20 to 100 per cent more in yield per acre than any other wheat. Its hard qualities make it secure from weevil or becoming musty and spoiling in vessels or elevators in transit. (Letter of October 9, 1897.)

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[1] See Annual Report U. S. Dept. of Agriculture, 1868, pp. 249, 250.

Again, in a letter dated April 15, 1898:

> Our farmers out here (Turnersville, Tex.) are well acquainted with the culture of this wheat, and the cause of their abandoning its culture was mainly twofold: (1) The indisposition of millers to handle it properly, and (2) the want of a market. The yield is certain. It tufts in winter (when sown in fall), pastures well, has a heavy straw, is easily threshed, and the best keeper of all cereals. The bread is nutritious, and for bakers' loaves it will not, after being baked, become dry and hard as bread from the softer varieties. The wheat grows sometimes as high as 6 feet and yields 60 bushels per acre. It grows well as far as Velasco, Tex., and flourishes where the tropical climate is no longer good for other wheats.

Mr. A. W. Parrott, proprietor of a stock farm at Holland, Tex., writes under date of May 24, 1898, concerning the Nicaragua wheat, as follows:

> We used to plant it here some eight or ten years ago. We made at that time from 25 to 30 bushels per acre. It would grow from breast height to the height of a man's head. It could be planted either in fall or spring. I planted 4 bushels last fall about November 15. It was very dry and the wheat did not get a very good start. I cut it last week and it will make double the yield that Mediterranean planted at the same time will make. Planted 6 bushels in February of this year. It was in full head, good stand and breast high, and will, with a good rain in a few days, make a great deal more than seed sown last fall, as there is a better stand. It is a surer crop than corn even, making on an average more to the acre than corn, besides requiring less labor to make and gather. It stands the cold better than our native wheats, thereby making a good and lasting winter pasture, and still producing a full crop of grain if not pastured too late.

The testimony of the Texas Seed and Floral Company, of Dallas, Tex. (in letter of May 24, 1898), is as follows:

> Nicaragua hard wheat was grown here several years ago, but the farmers stopped raising it on account of the millers not wanting to grind it, as it was so hard. It is very productive, and will produce one-third more than Mediterranean here, and makes splendid feed for hogs and other stock. We think it a good thing for the Texas farmer.

In 1899 this seed company kindly gave the writer the addresses of certain parties in Texas who were growing Nicaragua wheat. On request, reports were received from three of these parties giving their experience with the wheat as follows:

G. M. Givens, Lisbon, Tex.:

> I have been raising it for three years now. The first year (1896) I sowed it in December on account of getting the seed late. I got about 18 bushels per acre. The fall of 1897 I sowed 15th to 20th of October; had the finest winter pasture I ever saw, and harvested 30 bushels per acre, thresher measure, which weighed out a good deal more. My other wheat by the side of it, sown at the same time, made only 20 bushels per acre. The Nicaragua yields one-third more than Mediterranean with the same show. In the fall of 1898 I sowed Christmas week and got about 15 bushels per acre. We had no rain to amount to anything until spring. My other wheat made 10 to 12 bushels per acre. This fall (1899) I sowed Nicaragua November 10. It is a fine stand and doing well. It is a very hardy wheat, and when sown early will ripen about the same time as Mediterranean[1] or other bearded varieties. I think the proper time to sow is in October or November.

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[1] A standard red bearded wheat of Texas, and hence often referred to for comparison by Texas farmers.

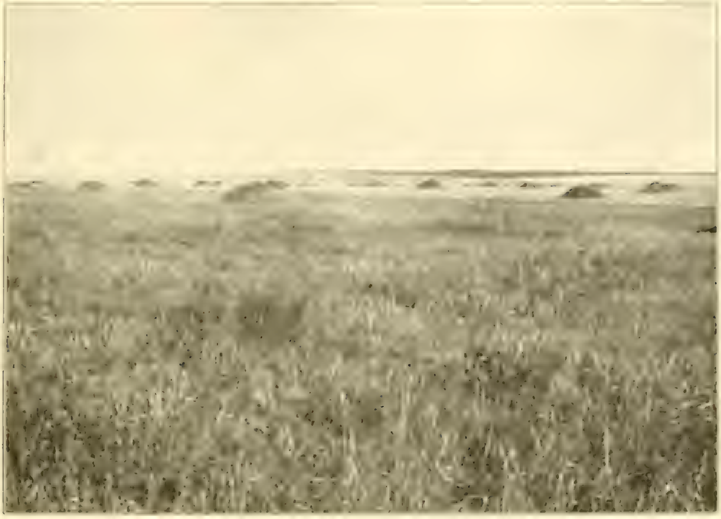

FIG. 1.—MACARONI WHEAT FIELDS NEAR BERDIANSK, IN THE AZOV SEA REGION.

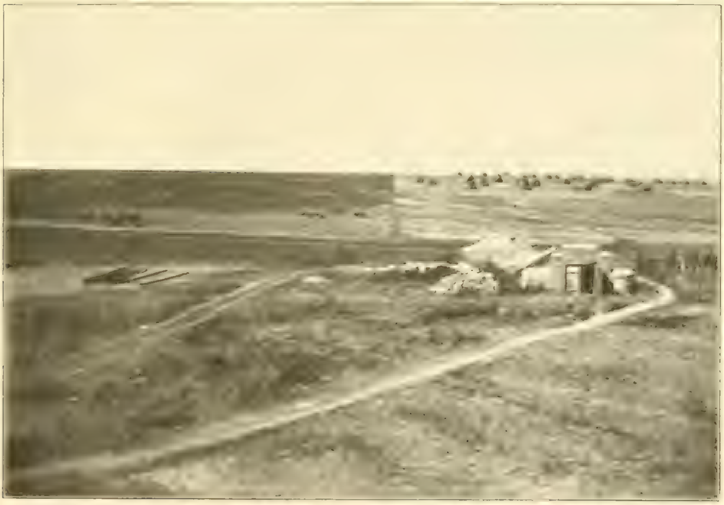

FIG. 2.—MACARONI WHEAT FARM OF MR. MIKHALKOV, AT AMBROCIEVKA IN DON TERRITORY.

N. B. Harrell, Celeste, Tex., November 20, 1899:

It has been sown here in this section and yielded a good crop, some of it making from 40 to 50 bushels per acre.

L. L. Ayers, Gatesville, Tex., November 18, 1899:

The wheat (Nicaragua) I sowed last year did not do well on account of late sowing and the almost unprecedented winter drought. It is a very hardy cereal, and should be sown about the time for other wheat and ripens about the same time. It is very productive in the black lands of Texas, yielding from 25 to 75 bushels per acre according to soil and season. Two years ago a farmer near Belton, Tex., raised 75 bushels per acre. It used to be raised here for hogs, but of late has fallen into disuse.

Mr. Edward K. Carr, of Kerrville, Kerr County, Tex., writes:

The remarkable success of Nicaragua wheat, which I have sown for about twenty-four years in succession on my farm, leads me to believe that we must look to Southern latitudes for our wheat.

Concerning Nicaragua, as tried in the North, Mr. J. F. O'Grady, of Eola, Roberts County, S. Dak., writes February 14, 1901:

I do not think the wheat had a fair trial last season, as it was a poor one for small grain in this locality. The sample was planted on April 20, the day that we finished seeding the common Blue Stem, which is the main variety used here, and Nicaragua came ripe a week ahead. Wheat averaged about 8 bushels per acre here, and the Nicaragua would have gone at least 50 per cent better.

Dr. F. W. D'Albini, of Waring, Tex., writing February 12, 1901, of results with No. 579 (variety Kubanka) of the Section of Seed and Plant Introduction, a macaroni wheat obtained by Prof. N. E. Hansen, says:

The plants were very robust and healthy and not inclined to lodge at all. There was little rust on them, though our common wheat showed it badly. The yield was very good. I think it would have made 22 bushels to the acre.

Mr. T. N. Oium, of Lisbon, N. Dak., who has been growing an excellent quality of macaroni wheat on a considerable scale, is one of the first to secure a market for his wheat at a good price. He is growing the variety Arnautka, originally from the Azov Sea region, and has this testimony to give from his own experience (letter of May 6, 1901):

In regard to the Arnautka wheat, will say that I have grown it for several years, and last year I had 1,000 bushels. * * * I find this wheat is admirably adapted to this country. It will yield about double what other wheat will and seems to be smut and rust proof. * * * I have succeeded in distributing enough seed so that with a normal crop I expect we will raise from 50,000 to 100,000 bushels next year. * * * Our local mill grinds flour from this wheat, and we like it much better than other flour. It makes better bread. All who use it here will use no other.[1]

The Hougen Milling Company, of Northwood, N. Dak., has not only grown macaroni wheat (of Russian origin), but has ground some of it for bread flour. The company writes as follows in a letter dated March 23, 1901:

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[1] The Arnautka wheat from North Dakota, given in Table IV, is a sample of the wheat grown by Mr. Oium. It compares very favorably with the others direct from Russia.

> We have made flour from about 200 bushels of this wheat. It takes considerable more power to grind the same quantity of this wheat than our spring wheat usually grown here. There will not be a great deal of this wheat sown here this year, as there has been no market for it. A few farmers will sow some, intending it for feed, as the yield is usually very good. We expect to put in about 100 acres of it, and in case we can find demand for the product there is no doubt a large amount of it will be raised here. The "grits" or breakfast food made from this wheat, a sample of which we send you, we think superior to that made from our native wheat.

Mr. Paul Landemann, of Scotland, S. Dak., and a former resident of Russia, has this to say in a letter of March 26, 1901, of the Arnautka wheat grown by German-Russian farmers in his section of South Dakota:

> I find that most of them have fed the last kernel of their seed to hogs on account of no market for this wheat, but everyone is happy that a market is in view, and it will take but a few years and there will be plenty. This wheat is not only good for macaroni, but it gives us a fine bread. Often in the city of Odessa I went to a well-known bakery to buy this bread, which was baked only twice a week, and found it all sold, to our sorrow. As soon as our American people will taste this bread it will find a sure market.

Concerning Kubanka wheat No. 2953 S. P. I. (Pl. I, *1*), obtained by the writer in 1898, the testimony of Mr. A. Meyerle, of Arapahoe, Nebr., is as follows:

> The wheat was planted April 26, 1899. It had one rain June 16, 1 inch, and no more rain till harvested. Harvested just seventy-six days after planting. It is so early, and that is what we want in this country.

Wheat No. 1174 S. P. I. (Pl. II, *4*), a macaroni variety obtained by Prof. N. E. Hansen from Turkestan, was tried by Mr. James Curtis at St. Thomas, N. Dak. He states results as follows:

> I planted it on the 10th of April, 1900, and harvested it on the 15th of August. Intend to give it another trial this spring (1901). It is a large plump berry and seems to be quite flinty. Grain men say that it will grade No. 1 northern.

Mr. James H. Campbell, writing from Skelton, Nev., says concerning the same variety, No. 1174:

> No. 1174 did well, better than our Nevada wheat. Planted April 1, ripened September 4. I gave the neighbors some to try.

This variety was also tried by Mr. A. B. Stanley at Echo, Umatilla County, Oreg. His testimony, given in a letter of February 12, 1901, is as follows:

> Wheat No. 1174 was sown broadcast March 26, 1900, and harvested June 29. Yield per acre (estimated), 23 bushels. The grain was large, plump, and far superior to the seed sown. I consider this variety worthy of further trial, which I shall give it the coming season. The fine stand of volunteer now on the ground, after the hard freezing weather of the last month, is evidence of its hardiness.

Mr. H. C. Warner, of Forestburg, S. Dak., superintendent of State fair, Department of the South Dakota State Board of Agriculture, has taken much interest in the trials of macaroni wheats. He experimented with Arnautka (S. P. I. Nos. 1153 and 1156) and No. 1174, and has this to say concerning results with it:

> A summary of results would be about as follows: 1153 and 1156 Arnautka were fine, withstood drought well, berry plump, color good, yield fine, ripe July 24. No. 1174 will be a good early wheat if it does not rust. Ripe July 7.

Three other correspondents report results with No. 1174, as follows:

> Alois Wallman, Crandon, S. Dak.: For durability it will prove to be the wheat best suited for the dry prairie States.
>
> H. J. Wilson, Husted, Colo.: No. 1174 was quite hardy; can not say what the yield would be, but consider it a good variety.
>
> C. A. Snodgrass, Salmon City, Idaho: It is the finest wheat I ever saw; I sowed it on the 10th of May and it was ripe on the 25th of August. It think if it were sown on fall plowing it would make a crop without irrigation, and, as to yield, I think it will yield fine. It seems to be hardy.

In Canada the Wild Goose wheat (Pl. I, *5*), a macaroni variety, which probably came originally from South Russia, has been grown considerably for several years. Mr. William Beacham, of Cambray, Ontario, writes April 3, 1901, as follows, concerning this wheat as grown in that locality:

> The straw is strong, not liable to lodge, and is not affected by rust at all. It does not shell in cutting as much as others if left till overripe. It will grow on wet or dry land and is not affected by extreme dry or wet weather.

TESTIMONY OF EXPERIMENT STATIONS.

Without any disparagement to the reports of private parties who, no doubt, state honestly the results of their experiences, it is nevertheless to the experiment stations that we must look for conclusions that are to be considered final concerning the behavior of varieties in their particular districts, as their variety tests are not only carried out scientifically and systematically, but in a highly comparative way, dozens, or even hundreds of varieties of different wheat groups being tested side by side, under the same conditions. No complete series of experiments with macaroni wheats has yet been published by any station, but several of the stations have kindly given the Department, by letter, brief reports of two-year results with the three varieties obtained in Russia by the writer in 1899, through the Section of Seed and Plant Introduction. In one instance the variety Nicaragua is also included. Fortunately, two of these stations are in the very districts to which these wheats are naturally best adapted.

The two States in which macaroni wheats have so far proved to be the most successful are North and South Dakota. The wheats not only give excellent yields in these States, but the grain produced is often apparently of better quality than the original imported seed. Prof. J. H. Shepperd, agriculturist of the North Dakota Station, reports briefly as follows the results with Kubanka and Pererodka at that station during 1899 and 1900:

> I am planning to do considerable work with macaroni wheat in this district. The two best Russian sorts outranked everything else. In 1899 Pererodka S. P. I. No. 2954 gave a yield of 39.9 bushels per acre and Kubanka S. P. I. No. 2953 yielded 30.1 bushels per acre. Both were very hardy and thrifty and were early enough to be entirely safe in this district. The Pererodka made a performance of about 8 bushels per acre better than our best-bred Fife and Blue Stem sorts. I am very favorably impressed with their performance indeed. The unusual conditions of last season (1900) vitiated the results of our work with wheat to such an extent that I have no confidence in the comparative yields which we obtained from the different sorts. Pererodka was subject to very adverse conditions from drought and conditions of soil, but made a yield of 17.13 bushels per acre even with so severe a handicap. The Pererodka is a very promising sort for this section.

In South Dakota comparative results indicate very strongly the hardiness of these Russian varieties. Concerning results at the station in 1900, a very discouraging season for the entire Northwest, Prof. D. A. Saunders writes:

> With reference to the macaroni wheats, Nos. 2954 and 2953 are very promising indeed. They both stood our drought wonderfully well, and yielded, in this very unfavorable season, somewhere about 30 bushels by the side of wheat that yielded 2 to 8 bushels to the acre. No. 2954 did not discolor quite as badly as No. 2953. Otherwise there is no difference between the two numbers.

Aside from their value for making macaroni and as a means of largely increasing the yield in the semiarid Great Plains, the use of these wheats will be one of the greatest factors also in the establishment of what is known as "dry farming" in the irrigated districts: that is, farming without irrigation. Prof. John A. Widtsoe, director of the Utah Station, is very favorably impressed with the behavior of Russian cereals in this respect. He has kindly furnished results of two years' experiments with these cereals in Utah, and writes as follows in regard to the matter:

> In accordance with your request for a brief report on the behavior of the Russian cereals sent us by the Department of Agriculture I am pleased to inclose a copy of the report on this subject made to me by the station agriculturist. As you will observe, some of the varieties sent us have done exceptionally well. I consider that this work is of very great importance to us here in Utah, especially as regards the discovery of wheats and other grains with great drought-resisting powers. Dry farming or farming without irrigation is becoming very important in Utah. The Utah Station is in constant receipt of requests for information and recommendations concerning varieties of wheat especially adapted for dry farming.

In the report mentioned from the station agriculturist, Lewis A. Merrill, is the following paragraph:

> It may be of interest to know that an exhibit was made, at our recent State fair, of these wheats, and they excited considerable favorable comment on account of the plump kernel, the color, the smoothness of bran, hardness, and general appearance.

In the following table are given the dates of seeding and harvesting, yields, etc., of the wheats only. Three of the varieties, Kubanka, Polish, and Pererodka, are Russian macaroni wheats. Romanov is also Russian, but not a macaroni wheat. The macaroni variety Nicaragua is included in the experiments of 1900.

TABLE III.—*Comparative results with wheat varieties at the Utah Agricultural Experiment Station.*

Name of variety.	S. P. I. No.	Year.	Date seeded.	Date harvested.	Number of irrigations.	Yield per acre, bushels.	Average yield.
Romanov		1898	Apr. 11	July 25	2	34.18	32.09
		1900	Mar. 19	Aug. 13	2	30.00	
Lamona	4276	1900	....do....	July 19	2	34.34	34.34
Pererodka	2954	1899	Apr. 13	July 28	2	36.00	34.63
		1900	Mar. 19	Aug. 13	2	33.27	
Kubanka	[illegible]	1899	Apr. 13	July 28	2	38.42	[illegible]
		1900	Mar. 19	Aug. 13	2	28.76	
Polish	2957	1899	Apr. 19	Aug. 7	2	29.50	25.25
		1900	Mar. 19	Aug. 13	2	21.00	
Wellman's Fife	4404	1900	....do....	July 23	2	32.50	32.50

It is seen that the highest yield of one year, 38.42 bushels, was made by Kubanka. The yields for Lamona and Wellman's Fife are given for only one year. These are known, however, to be fairly drought-resistant varieties. Of the four varieties that were grown two years Pererodka and Kubanka made the highest average yields, these being the same varieties, too, that were so successful in North and South Dakota. Pererodka seems again to be the better of the two varieties in this case, as was found to be true in the trials of the North Dakota Station. The writer saw these varieties in the shock just after harvest at the Utah Station in 1899, and observed then that the straw was long and the heads bright and well filled, though that was the first year of their trial. The wheats were given two irrigations, but it is probable that in the most favorable localities in Utah they will produce a good average crop without irrigation.

Polish wheat (Pl. II, *1*), a macaroni variety, has been grown along with other varieties at experiment stations and elsewhere in this country at various times, and almost always with good results as regards yield, drought resistance, and rust resistance. The experiments have always been short-lived, however, either from sheer neglect or because there was no particular incentive for growing the variety. In 1891 10 acres of this wheat was planted by the Division of Botany of this Department at its grass and forage experiment station at Garden City, Kans.[1] Two hundred and forty bushels were harvested, making a yield of 24 bushels per acre, or about twice the ordinary yield of spring wheats in that State. Dr. J. A. Sewall in his report of the experiments at that station for 1891 says:

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[1] See Report of Grass and Forage Expt. Sta. at Garden City, Kans., for 1891, by Dr. J. A. Sewall, pp. 3–5. Reprint from An. Rept. Sec. of Agr. 1891.

> With reference to the experiments as a whole, I know that with fair culture in this region, without irrigation, any person can raise ordinarily a fair crop of Polish wheat, and with a reasonable amount of rainfall, a large crop. Reports on the Polish wheat distributed last winter state a yield of from 20 to 60 bushels per acre, without irrigation. The rainfall from January 1, 1891, to May 21, 1891, was only 1.41 inches. From May 21 to October 3, 1891, the rainfall was 23.20 inches, nearly 3 inches more than the average annual rainfall.

Garden City is at a considerable distance west of the one hundredth meridian. This wheat also produced a good comparative yield at the Arkansas Valley Experiment Station in Colorado, but was apparently soon afterwards discarded. It has also given good results in Washington, Utah, Iowa, and other States.

The strong resistance to leaf rust exhibited by macaroni wheats has been discussed in detail in previous publications of this Department,[1] so that no special treatment of that subject is necessary here.

In closing this topic, the results of field trials with macaroni wheats in the semiarid districts of this country may be summarized as follows: (1) Macaroni wheats are far more resistant to leaf rust than common wheats; (2) they are more resistant to attacks of smut and other diseases than common wheats; (3) in the South, when sown in good time, they furnish a good supply of winter pasturage and that without diminishing the after harvest of grain, if not pastured too late; (4) in the middle Great Plains eastern Russian varieties ripen earlier, as a rule, than the ordinary spring wheats; (5) in many places west of the 100th meridian, where wheat growing with other varieties is practically impossible on account of drought, these varieties by virtue of their extreme drought-resistance will produce ordinarily a crop of from 12 to 20 bushels per acre; by the use of these wheats, therefore, these localities may become actual additions to the wheat area; (6) in the larger part of the Great Plains where drought is less intense, but sufficiently severe to make the average yield per acre of common wheats quite low, these varieties increase the yield on an average one third or more.

THE MARKET FOR MACARONI WHEAT.

From a purely cultural standpoint—that is, the standpoint of yield, hardiness, etc., there is no question that the success of macaroni wheat growing in the Great Plains of this country is even now an established certainty. There is only the question of a market that concerns the farmer at present. It is a question, however, that ought to be capable of early solution. A market is likely to be realized in one or more of three ways: (1) By stimulating a foreign demand for the wheat for macaroni making; (2) by the development of a home demand from our own macaroni factories; and (3) by the use of macaroni wheat flour in bread making.[1]

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[1] See Cereal Rusts of the United States, Bul. No. 16, Div. Veg. Phys. and Path., Dept. of Agr., pp. 23–40, especially pp. 33 and 40, Sept. 27, 1899 (illus.); also, The Basis for the Improvement of American Wheats, Bul. No. 24, Div. Veg. Phys. and Path., Dept of Agr., in column "Resistance to leaf rust," of table, pp. 44–58, Dec. 10, 1900.

FOREIGN DEMAND.

It is already known that certain French manufacturers of semolina desire to use macaroni wheat from this country, and indeed a considerable amount of the variety Wild Goose has been shipped to France. But at present there are apparently two chief obstacles in the way of extensive foreign shipments. First, the foreign factories have not been brought through proper middlemen to see what the grower has to offer. Second, there has been no systematic effort, as there should be, to send to these factories for inspection well-authenticated samples of our best grades of these wheats, with accompanying information as to the amount that can be furnished of each.

French factories are quite ready at any time to use these wheats if they can get always a good grade. The demand for such wheat is shown by the following statements of United States Consul, John C. Covert, at Lyons, France:[2]

> It is estimated that the French output of these pastes is from 120,000,000 to 170,000,000 pounds per annum, and the product is unquestionably destined to increase greatly. To Americans it may seem strange that the power to purchase wheat foods is only now becoming general in most of the civilized countries. Thirty years ago black rye bread was universally consumed by the working classes and the peasantry in France. Bakers tell me that they all sold rye bread up to about 1870; now it is rarely found in any bakery and is eaten only in the country. * * * As the use of wheat has become more general and the power to pay for it has grown correspondingly, it is but natural that a strong tendency to seek variety in its preparation for food should exist. * * * The new and better methods for the manufacture of the edible pastes, the knowledge of just the kind of pastes certain classes of wheat will produce, and the improvements in the heating and drying processes are coincident with the sudden and widespread increase in the use of wheat foods. The continued growth of this industry will depend upon the supply of special kinds of wheat, for a decline in consumption would immediately follow any attempt to manufacture pastes of ordinary wheat.
>
> Paste makers are unanimous in the opinion that American wheats [i. e., common bread wheats] will not answer their purposes, but when one considers the almost endless variety of our soil and climate it seems that some locality must be found where a suitable wheat can be grown. What is wanted is a hard wheat [durum, or macaroni wheat, not ordinary "hard wheat"] containing a large percentage of gluten and a relatively small percentage of starch. Our wheat is lacking in both

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[1] Since the above was written facts have developed upon which a market for at least 5,000,000 bushels can be safely guaranteed for the season of 1902.

[2] Wheat for Alimentary Pastes in France. Consular Reports, 60: 468–470, No. 226, July, 1899.

these desiderata. * * * An American chemist, Mr. Edwin W. Serrell, now living near Lyons [France], has carefully investigated this subject and informs me that the wheat which is now considered the best is that grown in the neighborhood of Taganrog,[1] Russia; the next is from Algeria. That produced in southern Italy, where the manufacture of pastes originated, has lost the high place it formerly held. The best wheat grown in France—considered better than the American product—is from the neighborhood of Clermont-Ferrand.

Rapidity of growth and ripening is considered of prime importance in the production of the desired qualities in the wheat. These are the chief factors in the Taganrog product. If our farmers could produce such a wheat it would find more uses than in the *pâtes alimentaires* above referred to. There would be an excellent market in years of drought in Russia.

Millers and bakers in France have found that bread is improved by putting into it a larger amount of gluten than is found in French or American wheats, and as a consequence very hard wheats—the Taganrog generally—are mixed with the others. These wheats can not be raised in France, but must be imported, and they are the only kinds which are always sure to find a market in this country [France], as the French farming community will always demand and are politically strong enough to secure a high protective tariff on wheat and other grain.

If it be remembered that the French people eat more bread than any people in the world; that, generally, France needs very little ordinary wheat, but that she always will need a very considerable percentage of hard wheat[2] (hard is not understood in the American sense in France), it will at once be seen that there is a possibility of finding a large opening for American agricultural products in this country, not to speak of the great consumption of hard wheat in such macaroni and spaghetti-eating countries as Italy and Spain. Moreover, as the experience of the French has proved that an admixture of hard wheat, in small quantities, improves the quality of the bread, it is reasonable to infer that this practice will extend to other countries,[3] further enlarging the market for hard wheats.

The following words appear also in Consular Reports, 62: 300–301, March, 1900:

Consul Skinner sends from Marseilles, December 1, 1899, the following copy of a letter from Messrs. Bendit Leinburger & Co., 21 rue Sylvabelle, Marseilles: "We are desirous of establishing connections with some first-class American grain exporters for the importation of American hard wheat into this market; and, as our efforts in this direction have thus far met with no satisfactory results, we make free to address you the present, in order to inquire if it is in your power to place our request before the proper party in the United States.

"This description of wheat, commonly known as Goose[4] wheat, is in considerable demand in our market. It is employed by the millers in this district for the manufacture of semolina, which is used in the production of macaroni, etc. It is better adapted for this purpose than any other quality of wheat. Russia, India, Africa, and to some extent Chile have been furnishing our market with this commodity hitherto. A clear, yellow-colored, and well-cleaned wheat will always command full prices."

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[1] Nearly all Russian macaroni wheat is known in France as Taganrog, simply because Taganrog is the chief point of export. As a matter of fact some of the very best of this wheat is grown in the Volga River region.

[2] Nearly all French wheat is very soft, much softer than our wheats, but imported wheats of the durum group are mixed with them for making bread.

[3] In Eastern Russia macaroni wheats have been used in bread making on a large scale for many years, a fact not generally known.

[4] Grown rarely in North and South Dakota, but in larger quantities in Canada. See Pl. I, fig. 5.

Mr. Skinner adds: "I have already communicated to Messrs. Bendit Leinburger & Co. the facts set forth on page 400 of Consular Reports No. 230. There is no doubt that wheat of the quality described would meet with a steady demand in this market. I might add in this connection, however, that a local firm other than the one named above complains to me that certain transactions with American exporters proved unfortunate, because of the arrival of the grain in bad condition and not as represented by sample."

In 1899 Mr. James B. Simpson, of Dallas, Tex., being much interested in the statements of Consul John C. Covert above quoted, since it indicated a possible outlet for Texas-grown Nicaragua wheat, wrote this Department requesting its assistance in forwarding 2 bushels of this wheat to the United States consul at Lyons to be tested as to its fitness for use by French manufacturers of edible pastes. The letter was referred to the Department of State. It was accompanied by another letter, which was also printed in the Galveston News, and from which the following words are here quoted:[1]

> Believing that the wheat exactly adapted to the making of macaroni and similar edible pastes is that hard, flinty, glutinous wheat called in north Texas the Nicaragua wheat, and seemingly almost indigenous to our black lands and warm climate, and knowing that there never was a failure in the growth of this grain in north Texas, and that such is its wonderful productiveness that an average of 50 bushels to the acre is made, I took occasion to write these facts to Mr. Covert.
>
> Mr. Covert became deeply interested in my letter, realizing at once the great possibilities to north Texas, and referred it to M. Edwin W. Serrell, a distinguished chemist of Chabeuil, France. That gentleman wrote in reply a letter of some six pages (too long to insert here), but substantially stating that if we could grow this character of wheat a practically limitless demand existed for it in Europe, and that it could readily be shipped through Galveston.
>
> Mr. Serrell further suggested that he be sent 2 bushels of this Texas-grown wheat for chemical analysis, which he would gladly make; and if it was as anticipated, not only could France take all produced in north Texas, but that capital would quickly come from France to Texas, putting up here establishments with a yearly output of $18,000,000.
>
> Since I have taken up this grain matter, I have spoken with several farmers of Dallas County, who are unanimous in their opinion that we can grow to perfection in north Texas just the wheat required by this great European industry, and so satisfactory would be found the profits that our black lands would advance quickly from 25 to 50 per cent in value.

Letters of recent date have been received through the Department of State from the consuls at both Marseilles and Lyons, responding courteously to requests for certain information by this Department. In these letters reference is made again to the foreign demand for macaroni wheats. Consul Robert P. Skinner, at Marseilles, in a letter of February 6, 1901, says:

> As to whether or not it would pay American farmers to export their wheats to France, I think there is no question. Buyers here are constantly looking for hard

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[1] See "American wheat for the manufacture of macaroni," Consular Reports 61: 400, 401, No. 230, Nov., 1899.

wheats comparable to those exported from Russia to this market. It has been found impossible to grow these wheats in France, and the supply produced in Algeria is quite insufficient to meet local requirements.

Consul Covert, at Lyons, also makes the following statement regarding the same matter in a letter of March 8, 1901:

> As to the European market for hard wheats, I am told by dealers that it will be able to absorb all that our country can produce. I know merchants in this city who would like to contract for handling large quantities of these wheats.

The foregoing statements refer to France only. Equal demands exist, no doubt, in Italy. Consul Joseph E. Hayden, at Castellamare di Stabia, Italy, also states in a letter of April 25, 1901, with reference to Italian macaroni—

> In the manufacture of macaroni of the best quality a special kind of wheat is used called "hard wheat," and for the making of cheap macaroni a mixed wheat is used. This mixed wheat is neither hard nor soft. Nearly all the hard wheat comes from Russia, but some comes from India, the Orient, Tunis, and Turkey. Italy would be a very important market for American wheat, either soft or hard.

Again, in another place and more recently he gives a more extensive report on the subject,[1] as follows:

> After efforts covering a period of over two years, I have succeeded in demonstrating the fact that the very finest quality of macaroni can be made of American wheat. This has been declared an impossibility by those engaged in its manufacture here, and there are hundreds of establishments in this district. Up to the present time Russian wheat and wheat from the Orient have been used, together with Italian wheat, for the production of this article of food, the American wheat being considered too soft. Through the cooperation of one of the largest establishments in this district it has been found that this conclusion was based upon the proverbial conservatism of the people. When it is remembered that macaroni consists of wheat to the extent of 60 per cent, it will be readily seen that here is an opening for American wheat of no inconsiderable importance. It should be understood that while there is a tax on American wheat there is also a tax on all foreign wheat—7.50 francs ($1.44) for 100 kilograms (220.46 pounds). It should also be borne in mind that international freights covering transportation of grain from Russia, the Orient, and the United States are practically the same.
>
> I inclose extracts from a letter from one of the largest manufacturers in Italy and send also a sample of crude American wheat, with a sample of the wheat ground and a sample of macaroni made from the same.[2] It has been suggested to me that if the United States Government would admit free of duty, or at least at a lower tax than the present tariff, macaroni made from American wheat, a market for our wheat would be opened in competition with that of Russia and the East. The present tariff on 1,000 pounds of macaroni is $15, or 1½ cents per pound; under the plan proposed 60 per cent of the said 1,000 pounds would enter free, leaving 40 per cent to be taxed at the present rate of 1½ cents per pound, making on the 1,000

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[1] "American wheat for Italian macaroni," Advance Sheets of Consular Reports, No. 1071, pp. 1, 2, June 25, 1901.

[2] The samples were transmitted to this Department together with a copy of the report. A portion of the wheat sample is true macaroni wheat, but a large portion is ordinary bread wheat, and the whole of it has been very poorly cleaned. If this makes good macaroni, as stated by the Italian manufacturer, our best well-cleaned grain will find abundant demand.

pounds a tax of $6 instead of $15. It should be remembered in this connection that the Italian manufacturer of macaroni under the scheme proposed would have to pay freight from the United States to Italy, and also pay freight on the same wheat manufactured into macaroni and transported to the United States.

EXTRACTS FROM LETTER OF DOMENICO ORSINI.

I send you herewith the result of my experiments in producing macaroni from American wheat. Up to this time, I am sure no Italian manufacturer of macaroni thought it was possible, believing it necessary to use a mixture of either Italian and Russian wheat, or of wheat from the Orient and Tunis. I now put in your possession the accomplished fact, which will serve to open up in Italy a wide market for American wheat. America imports macaroni from Italy, mostly from this district. The wheat used, samples of which are here inclosed, is known as "unfalcated wheat," and was purchased by me in New York City. You will notice the rich golden color of the macaroni, and as to its consistency, I would note that it can be cooked in one-half the time consumed in the preparation of the macaroni now in use.

Not only is there a great demand for such wheats in southern Europe, but American macaroni wheat has already found its way to that market in small quantities. It is chiefly the Wild Goose wheat, exported mainly from Canada. Concerning this matter the following statements are made in the report for 1900 of the Ontario Agricultural College and Experimental Farm:[1]

There has been a considerable demand in Italy and France for the Wild Goose wheat within the past four years. One firm alone in Toronto exported in all about 600,000 bushels of the Wild Goose spring wheat in 1899. About one-half of this went to Italy and the other half to France. It is estimated that nearly 90 per cent of the Wild Goose spring wheat which is shipped from Canada is used for the manufacture of macaroni. The price of the Wild Goose for export purposes will likely vary somewhat from year to year, as our keenest competitors are Russia, India, and Turkey. If the crops of these countries are good, the quantity which is shipped from Canada is correspondingly reduced. It is thought, however, that there will be a good demand from the Mediterranean and from other continental ports for Ontario grown Goose wheat for a long time, providing the quality is good.[2]

But if such sales have been made and are being made of this Canada grown Wild Goose wheat, the prospects should be very hopeful for a constant foreign demand sufficient for the disposal of all the Kubanka and Gharnovka (or Arnautka) wheat that can be grown for several years in North and South Dakota, Nebraska, and Colorado, where the quality of the grain produced is already known to be superior, the product being much more uniform and usually free of soft grains. This leads naturally to a discussion of the necessary character of the grain required.

QUALITY OF GRAIN DEMANDED.

As already stated in another place, a clear, almost translucent, very hard, yellowish grain is, in a general way, what is required in the foreign market, just such a grain as can unquestionably be produced, too, and is being produced in the greatest perfection in the northern States of the Great Plains. It is also especially important that there shall be no admixture of soft or otherwise inferior grains, but that the entire crop shall be uniform in the quality of grain. It is because of lack of attention to these requirements and occasional careless inspection of grain in this country that there has not been even greater demand than now exists for our wheats. Consul Skinner offers some suggestions of warning in this connection which are of special value, as he is situated at Marseilles, the chief port of entry for macaroni wheat imported into France. His statements are as follows:

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[1] Twenty-sixth An. Rept. Ontario Agr. Coll. & Expt. Farm, p. 102. 1900.

[2] In a letter of very recent date Consul Skinner reports that 100,000 tons (3⅓ million bushels) of this wheat has arrived at Marseilles from Canada since March 1, 1901.

> (1) In letter of February 6, 1901: One of the manufacturers in this city has very recently been called upon to test a shipment of Goose wheat from Manitoba, and mentioned to me the other day that the result was extremely unsatisfactory, as the quality of the grain was not even, a large percentage of the kernels being sufficiently hard, and the remainder not harder than ordinary winter wheat. (2) Concerning grain inspection:[1] Three protests have been formerly lodged with me in regard to the condition of a cargo of wheat arriving from New Orleans; a like complaint has been made against wheat from Galveston, and an English trade paper noting a communication from its Marseilles correspondent, says, "We may add that London importers have been making similar complaints." These facts suggest that whatever accuracy the criticism may possess, they are not confined to an isolated case or to a single city. As my correspondents explain, wheat from New Orleans is purchased in Marseilles on the faith of the certificates of inspection issued by the board of trade of that city. The exporter appears to have no responsibility for quality of the grain beyond the production of an "official" certificate of inspection, which being in proper form binds the buyer to accept the consignment. It necessarily follows that unless the trade organizations issuing certificates exercise proper care in making the statements conform to the facts, they must lose credit and drive business into other channels.

Mr. Skinner also emphasizes the desirability of submitting standard samples of each year's crop at Marseilles in the following words:

> Many American cereals are unknown here. I have conversed with several brokers who say that if they had samples of the new American crop they could make sales. This difficulty could be overcome and a step in advance of every other grain exporting nation would be taken if our produce exchanges, notably at Chicago and New York, would send to this market annually, after the new crop is in, a complete set of standard samples. To reach the trade of Marseilles, two sets should be sent—one to the Chambre Syndicale des Minotiers et des Fabricants de Semoules de Marseille, 4 rue des Templiers, and the other to the Chambre Arbitrale des Cereales de Marseille, sitting at the bourse. The utility of the suggestion is shown by the fact that the French consul at New Orleans has forwarded some few samples to the Syndicate des Minotiers by request. Samples should be selected with scrupulous care, indorsed by the exchange sending them and sealed by the French consul, in order to be fully accepted here. The idea is applicable not only to cereals, but to cotton, oils, etc. I am extremely desirous of having this matter considered and acted upon, and will be happy to see that samples are properly placed.

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[1] Inaccuracy in American Grain Inspection. Consular Reports, 62: 303–305, No. 234. March, 1900.

In regard to the same matter of a guaranteed product being necessary to insure an extension of our wheat trade, the situation as concerns our export to Malta (where hard wheat is mainly used at present, coming chiefly from Russia) is stated by Consul John H. Grout, jr.[1] With special reference to a cargo of wheat and flour shipped direct from New York to Malta in 1899, he says:

> Unfortunately the wheat sent was not up to the standard required for military use. I have received a fair sample of it, and find it full of tares and unclean. The grains also are too small. This makes the second time that wheat from the United States has been received and each time it was below the standard. I wish to state as a result of my recent investigations on the subject, that although there is every chance for our wheat to gain this market, no headway will be made with such qualities as have thus far been received. It is utterly useless for our shippers to send wheat that will not come up to the requirements. I know that we have the required article, and it only rests with those desirous to secure a market here to send large samples first and then, if accepted, to send wheat equal to the samples. * * * Mr. Turnbull, of Turnbull, jr., & Somerville, Valleta, recently said to me: "We have large dealings with the Government here and desire to secure an American brand of wheat that will be acceptable. We desire to do business with some responsible American firm that will send us samples of wheat up to the standard, and that will, if we order from them, send us wheat up to the sample." * * *
>
> In sending samples one thing must be strictly remembered, and that is not to send poor wheat. At Malta the question is not cost, but quality. There are several good firms here that are ready to deal with our exporters. Among them are the firms above mentioned—C. Breed Eynaud & Co. and S. Scicluna & Son. The latter firm has for some time been trying to get some samples of American wheat of good quality, but thus far has not succeeded in securing what is most desired.[2]

Whatever we may think of the justness of the above criticisms, the suggestion of Consul Skinner that certified samples of each year's crop be placed with chambers of commerce at Marseilles and other ports is manifestly of the greatest importance. Such a course will be particularly effective in securing a quick market for our macaroni wheat, and the writer would urge upon our produce exchanges and boards of trade the desirability of carrying out such a plan at once after each harvest. Let the samples be in duplicate or triplicate for each foreign market, and be large enough and of sufficiently average character to represent the crop as accurately as possible. Duplicate samples with corresponding numbers should be kept by the home association, of course. Then, what is still more important, let no consignment be permitted that is not "up to" sample sent. It is absurd to think that anything is gained in making a shipment inferior to the sample on the basis of which the purchase price is paid; but, on the other hand, the entire market may be lost because of a few shipments of that kind. The importer should be able to buy by sample with positive assurance of getting just what he has ordered. The slight changes that are undergone in storage or long transportation are soon understood by the experienced dealer. In the purchase of these macaroni wheats especially no dependence can be placed upon a mere statement of grades without accompanying samples, for three reasons: (1) Because these wheats are in this country a new factor to the grain inspector, who can not yet grade them understandingly; (2) there is at present a grievous lack of uniformity in grading even our ordinary wheats; and (3) the manufacture of semolina for macaroni requires certain qualities in the grain that are not usually considered in ordinary grain inspection.

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[1] American wheat at Malta, Consular Reports, 60 : 479, 480, No. 226, July, 1899.

[2] For further discussion of this subject see testimony of Frank H. Hitchcock, Chief, Section Foreign Markets, before the Industrial Commission; Foreign Markets for American Agricultural Products, Rept. No. 67, U. S. Dept. Agr., Washington, 1901, pp. 32–42.

In all tests that have so far been made of American macaroni wheats by the semolina manufacturers of France the results have been fairly satisfactory, it being stated in several instances that the semolina is fully equal to that of the Taganrog wheats. But these tests have been made almost wholly with Texas and Canadian wheats, which are apparently inferior to those grown in the northern and middle Great Plains. The writer firmly believes that when the North and South Dakota macaroni wheats shall be thoroughly tested in foreign factories they will be acknowledged to equal in quality any other wheat of that kind in the world.

In an article entitled "Wheat for edible pastes in France," Consul Covert reports to the State Department[1] the results of tests made of the 2 bushels of Nicaragua wheat sent to him by Mr. James B. Simpson, as already noted.[2] Messrs. Gilibert & Teziers, Valence, France, reported upon a package sent them as follows:

> Macaroni can be made out of this wheat, but of an ordinary quality, because it can not contain a great deal of gluten. It contains considerable soft wheat, and some of it is *mouchetés;* that is to say, black about ends. It seems to us that wheat more evenly hard and not *mouchetés* ought to be grown in Texas. The wheat which we want would bring at Marseilles about 18 francs ($3.47) per 100 kilograms (220.46 pounds).

Another package sent to Mr. Edwin W. Serrell, at Paris, was given to an expert for examination, who reported as follows:

ITS FORM.

> Long grains, indicating a high average of gluten. A horny or corneous form; the best variety of hard wheat. It is, in fact, very hard.
>
> Grains regular in size.
>
> But very little impurity; a few grains of tender white wheat.
>
> Unfortunately there are a few spotted grains. This defect, which ought not to be inherent in the quality, diminishes the value somewhat, for it will necessitate more time for sifting to eliminate the black spots from the semolina.

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[1] Wheat for Edible Pastes in France. Consular Reports. 62: 301, 302. No. 234. March, 1900.

[2] Page 31.

ANALYSIS OF THE GLUTEN.

Paste very rapidly obtained.

Gluten very easily separated; very homogeneous and elastic. The analysis shows damp gluten 30 per cent; dry gluten 10 per cent.

These proportions occur only in the superior grades of hard Russian wheat.

With well sifted semolina there could be made from this wheat edible pastes carrying 13.33 per cent of gluten. This wheat would therefore make the best qualities of edible pastes.

Mr. Covert adds:

> The above report coming with Mr. Serrel's indorsement should leave no doubt as to the value of pastes, for no man in Europe is more competent than he to pronounce an opinion on this subject.
>
> The gentleman to whom I sent specimens of this wheat in Marseilles reported verbally that it would find a ready market in that city at 16 francs ($3.08) per 100 kilograms. Dealers have been one week investigating this subject in Marseilles. Their first report was favorable. This morning they confirm the first opinion.

While the above reports are in the main favorable, the considerable number of grains with black ends is a detriment. These grains were noted by the writer in samples from the same source sent to this Department for the Paris Exposition of 1900, and were at once considered to be the result of being grown in a locality a little too damp. In Russia macaroni varieties when grown in a locality too damp likewise deteriorate in the same manner. The use of Taganrog wheat for seed in Texas, as suggested by the French manufacturer,[1] would therefore probably make little difference. The defect will no doubt best be overcome, as the writer has before suggested, by growing the wheat farther westward, in the region between Wichita Falls and Abilene. The present Nicaragua wheat area in Texas, if extended over one-half its width westward, would furnish a quality of grain much superior to what it now produces. At the same time it would add to the general wheat area of the State thousands of acres of semiarid lands at present supposed to be unsuited to wheat culture, but which would yield a good average crop of this wheat because of its drought resistance. The writer has observed that this wheat, when grown in eastern Colorado or extreme western Kansas, produces a grain as clear, hard, and yellow as the east and south Russian wheats.

As the traffic in macaroni wheats increases it will be necessary to construct special elevators for handling them. It is plainly impossible to handle these wheats and the common wheats together, as each would ruin the other by the mixture. There ought to be, and probably will be, a sufficient amount of these wheats grown in the next five years to justify the construction of several large terminal elevators at such points as Galveston, Chicago, and Minneapolis, in addition to various smaller local elevators, all of which will handle only macaroni wheats.

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[1] See "Wheat for edible pastes," by John C. Covert, Advance Sheets of Consular Reports, No. 668, pp. 5, 6, March 3, 1900.

POSSIBILITY OF A HOME DEMAND.

While the prospects are very good for a foreign market for these wheats sufficient to utilize probably all that we can produce for several years, an excellent market is also likely to be developed sooner or later in our own macaroni factories. At present all these factories, with rare exceptions, use the flour of common bread wheats in their operations. Of course this is chiefly due to the fact that heretofore it has been impossible to obtain true macaroni wheats in this country, and it is considered impracticable to import them. Most of the factories realize the importance of using the semolina of such wheats as soon as they can obtain it in sufficient amount and of good quality. It will certainly be of the greatest advantage to the factories as well as to the growers to establish trade between them in the use of these wheats. The factories will thus be able to obtain either the wheats or semolina made from them at much less cost than the imported material, and the farmers will have the benefit of a quick home market.

Another strong advantage in using these wheats in our own factories, and which especially affects the consumer, lies in the fact that the homemade product, other conditions being equal, is always much better from the standpoint of simple freshness. We all know how much better fresh bread is than old, and what a nutty flavor newly-made flour gives to the bread. These facts apply with even greater force in macaroni making. All imported macaronis must of necessity have lost a large per cent of their flavor, and as the homemade product is made almost entirely from common wheats, it follows that the majority of American people really have never tasted the very best macaroni.

More than all else the use of macaroni as a food is far from general in this country, and should become more popular. It is a comparatively rare food with us. As already quoted in another place, in France alone the annual output of edible pastes is estimated at from 120,000,000 to 170,000,000 pounds. A considerable amount of this is of course exported, but there remains an enormous amount which is consumed in France. These pastes are among the most common and popular foods in that country. The same may be said of Italy. Let a sufficient amount of good wheat be grown and our factories begin producing from these wheats its best article possible, in a variety of forms, and there is no good reason apparent why such foods should not soon rank in popularity with our breakfast foods.

Concerning the question of a home demand for macaroni and macaroni wheats, Consul Skinner writes as follows:

> While the cultivation of a hard wheat suitable for the manufacture of macaroni for export to Europe is a matter of great importance to our people, I consider of equal importance, if not greater, the creation of a demand in the United States for a macaroni for domestic consumption. Macaroni in southern Europe takes a hundred different forms, and constitutes a staple article of diet that is cheap and palatable. Its

possibilities in America are quite unknown, and macaroni in its most ordinary form is consumed in a very small number of families. Nor are these facts the result of popular ignorance entirely, for macaroni and semoule, to be good, should be manufactured in the country of consumption, as the deterioration in quality sets in even a few weeks after production. It necessarily results from this that the macaroni exposed for sale in American shops and imported from Europe is stale and tough, and therefore little in demand. I have no doubt you have seen, as I have frequently, large cases of bulk macaroni exposed to the air for weeks in small grocers' shops. What is true of macaroni is still more so of the semoule or flour from which macaroni is produced. This flour is in a moist state, and could not be used by the French manufacturers of first-class macaroni two months after grinding, and in most cases goes directly from the mill to the factory. A few importers do succeed in packing semoule in tight cases, but even with these precautions it loses much, and the demand for it in the United States is trifling indeed.

Similarly, Consul Covert makes the following statement:

But an important market ought soon to be created for them (macaroni wheats) in the United States. The edible paste factories make paste of hard and soft wheats with the same machinery. Soft wheat, however, is most used in Belgium and in the Vosges, a department in France. The best pastes are made with hard wheats. The use of edible pastes is steadily increasing in Europe and there is no reason why the same should not be true of the United States. It is a common article of food in the wealthy families of this country and is of daily use among the poor. It is cooked with meat, cheese, vegetables, and in various forms used in soups and sauces. The French paste makers are said at present to lead the world in this product, and if Americans expect to obtain the custom of our country which now goes to France they should lose no time in using only hard wheats. The same identical machinery is used whether the wheat is hard or soft.

KINDS OF WHEAT NOW USED BY OUR FACTORIES.

There are at least fifty rather large macaroni factories known by the writer to exist in the United States, and no doubt there are many others. With a number of these factories the Department is in regular correspondence, and has found the manufacturers, with few exceptions, to be fully awake to the advantages of using macaroni wheats and desiring to obtain semolina from such wheats wherever they can do so. In the absence of such wheats it is interesting to know that they almost invariably use the very hardest red wheats that are grown in this country, chiefly Kansas hard winter and the hard spring wheats, which is in itself virtually an admission on their part that the harder the wheat the better. The following extracts from a few letters show fairly well the trend of opinion among the mills and factories along this line:

(1) We are now using a mixture of hard Kansas wheat and the hardest grades of winter wheat that we can obtain in this vicinity for our macaroni purposes. This makes a fairly good article of macaroni, but we have no doubt but that the true macaroni wheat would make a superior article. We have never been able to obtain the same, and if we could now get a supply of this wheat we should be very glad, indeed, to do so. Any information that you can give that would assist us in getting this wheat would be highly appreciated. * * * In the meantime could you tell

us where the name Arnautka[1] wheat comes from. We had never before heard of wheat under that name, but recently have had some correspondence with a party in North Dakota who raises a wheat called Arnautka, and from a sample we are satisfied that it would be just what we wanted for macaroni purposes. (2) I have given the subject of macaroni flour special study, and as a result have on hand more than twenty different samples of wheat flour sent me from Europe. In my estimation there is nothing like it raised in this country, and I am certain that if it should be raised there would be a good market for it among macaroni manufacturers. We are using at present the bread flour manufactured by the Minneapolis mills, which gives very satisfactory results, but not equal to the imported Italian macaroni. There is no question in my mind that if the American farmer produces it he will receive a premium for the right kind of wheat for macaroni. Kindly inform us where this particular wheat is being raised in the United States, and in what quantities. If at any time you come across an enterprising miller who will grind macaroni wheat and is willing to cooperate with the manufacture of it into macaroni, kindly refer him to us. We will be always ready to manufacture from that high grade of wheat. (3) We are using in our factory flour, and have also used farina, which we get from districts where they raise the hardest spring wheat, and the result has been very satisfactory, it being equally as good as the imported. (4) We find the flour which gives us the best results is that which is made from wheat grown in northern Kansas. This wheat is very hard and contains a very large percentage of gluten, which is necessary for a good macaroni. (5) I only use in the manufacture of the goods the best grade of spring-wheat flour, preferably of Minnesota wheat. (6) We agree with some other manufacturers that so-called Taganrog wheat is slightly superior to the American wheat, it having more gluten; and again we know it to be a fact that a hard spring-wheat flour, if properly used, produces goods that are equal to imported and only an expert can tell the difference. * * * We are using the high grades of spring and winter wheat flour. (7) We are using the ordinary bread wheats called "Kansas hard wheat" for the manufacture of macaroni, which has proven quite satisfactory, but not of a quality equal to the true macaroni wheats. * * * The macaroni wheat is, of course, much superior to the ordinary bread wheat in the production of macaroni, and if the flour could be produced at a reasonable price a much superior article could be produced and the industry stimulated in a corresponding degree. (8) We would be only too pleased to use it (macaroni wheat) in preference to other wheat flour; for we feel confident that with the improved American method, and using Taganrog flour, the American product would be superior to the imported article now used in this country, and we heartily approve of your ideas in experimenting and raising an American product. (9) All the manufacturers here of macaroni and all grades of the Italian paste, with the exception of one, use the grade of flour manufactured from wheat grown in the arid section of northwestern Kansas and known as the Russian hard winter wheat. * * * Macaroni made from ordinary wheat will not do. This has been demonstrated time and again. Of course macaroni can be made and the goods will have a limited sale; but to insure success in that branch of manufacturing industries the quality of wheat must be such as to insure satisfaction to the patrons. We have an idea that the wheat which was introduced here some time ago from Nicaragua, and which was turned down by all the mills that had given it a trial as being worthless, is just the quality adapted to the manufacture of macaroni.

The above reports are from some of the most prominent manufacturers in that line in the principal cities where this industry is carried on.

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[1] As mentioned in another place, this variety is a macaroni wheat already grown to a slight extent in North and South Dakota, and which came originally from Russia. The derivation of the name is uncertain.

COMPARISON OF FOREIGN AND DOMESTIC MACARONI.

It is rather difficult for one who is not an expert to compare the American and foreign products, especially since the foreign is necessarily quite old before it can be obtained, and therefore has deteriorated more or less. There are in general these differences, however, which are usually quite distinct: (1) The foreign is yellowish, the domestic white or grayish white; (2) the foreign is more vitreous in fracture than the domestic; (3) the foreign preserves its shape longer in cooking than the domestic; (4) the foreign is more elastic and not sticky in chewing like the domestic. The word foreign must be understood here to apply to the best French and Italian products made from true macaroni wheats. Of course there is a considerable amount of foreign pastes made from soft wheats and really inferior to our own products. In actual kitchen trials of various samples it will be found that the product made from our hardest bread wheats, by virtue of improved methods of manufacture, is really very good, but always falls a little short of the foreign in quality. This being true, it is possible that our best factories, using true macaroni wheats as grown in this country, would produce an article superior to the best foreign product.

In the following table are shown such differences as exist between a number of various grades of macaroni from a chemical standpoint:

Table IV.—*Analyses of macaroni produced from different wheats, results expressed as percentages.*

Name of product.	Kind of wheat from which made.	Moisture.	Fat.	Crude fiber.	Ash.	Protein.	Carbohydrates by difference.
Egg noodles	Hard spring (with eggs)	9.27	4.36	0.31	0.71	15.63	69.72
Spaghetti	Bread wheat, kind unknown.	9.55	.47	.71	.57	12.63	76.06
Macaroni	do	10.20	.38	.52	.61	12.31	75.98
Do	Kansas hard winter	10.36	.38	.57	.51	12.06	76.12
Do	Dakota and Minnesota	10.24	.43	.37	.43	11.06	77.47
Spaghetti	do	10.15	.44	.37	.44	12.63	75.97
Mezzani	Minnesota spring	10.20	.22	.38	.32	12.56	76.32
Macaroni	Hard bread wheat	10.19	.42	.37	.43	13.88	74.71
Spaghetti	Hard spring	10.15	.19	.40	.56	13.44	75.26
Do	Kansas hard winter	10.06	.56	.35	.47	12.56	76.00
Macaroni	do	10.06	.46	.49	.45	12.63	75.91
Macaroni (artificially colored).	Hard spring	9.44	.26	.46	.67	13.25	75.92
Macaroni	Mixed hard and soft bread wheat.	9.58	.19	.53	.83	14.75	74.92
Do	Mixed Kansas hard and ordinary winter.	9.79	.49	.38	.63	12.63	76.08
Macaroni (splits easily).	do	10.00	.40	37	.62	12.75	75.86
Macaroni (very large).	Hard bread wheat	9.73	.45	.38	.48	14.06	74.90

TABLE IV.—*Analyses of macaroni produced from different wheats, results expressed as percentages*—Continued.

[illegible]	Kind of wheat from which made.	Moisture.	Fat.	Crude fiber.	Ash.	Protein.	Carbohydrates by difference.
Macaroni (genuine Italian imported).	Unknown	10.05	.24	.50	.65	13.06	75.50
Macaroni	Grown to order	9.91	.49	.39	.41	12.06	76.71
Do	Pillsbury's best flour	9.61	.58	.38	.43	13.81	75.19
Do	True macaroni wheat grown to order.	10.50	.75	.22	.50	17.13	70.90
Mezzani	Imported Taganrog	10.25	.58	.22	.64	10.19	78.12
Macaroni	Best Minnesota spring	10.29	.67	.23	.43	12.38	76.00
Macaroni (genuine French imported).	Unknown	10.02	.39	.25	.71	12.25	76.38
Mezzani (genuine Italian imported).	American mixed durum and bread wheat.	10.88	.41	.23	.53	11.50	76.43
Macaroni	Bread wheat, kind unknown.	11.88	.40	.27	.52	10.06	76.87

These analyses were made by the Bureau of Chemistry of this Department, and include 21 domestic samples of macaroni and spaghetti, a sample of French and two of Italian production, and a sample of egg noodles. As already mentioned, it will be noted how much of these pastes is made from our hardest bread wheats, in the absence of the proper durum wheats. It is an indication of the fact that the very hardest wheats are required, and therefore the sooner the real durum wheats can be obtained the better for the factories. Comparing this table with Table V it is seen that the average protein content of these samples is considerably less than that which could be obtained from true macaroni wheats if they were used instead. The difference is even greater than here shown, however, since in Table V only the albuminoids are given, while in Table IV the entire protein content is given. In connection with these facts it is interesting to note that the one sample only, made from true macaroni wheat,[1] shows a protein content at least 2 per cent higher than the best of the others, and a correspondingly low percentage of carbohydrates. The protein content of the egg noodles is of course increased by the addition of egg. Of still further interest, and much importance to us, is the fact of the high protein content of the Arnautka wheat from North Dakota, mentioned under remarks in Table V.

The gluten content of these macaroni samples was also determined, but on account of the great changes in the gluten effected in drying the macaroni during its manufacture, these results are entirely misleading and of no value in this connection.

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[1] The writer has examined this wheat and knows it to be a good quality of real durum wheat. It is the only instance in this country known to the writer where macaroni is already being made from durum wheat, though one other factory is preparing to put out a product from the same class of wheat.

PREPARATION OF SEMOLINA.

Macaroni factories, with few exceptions, obtain their flour or semolina already prepared. In this country, while the bread wheats are being used, it is a comparatively simple matter, the flour being obtained from the ordinary flour mills. In Marseilles the preparation of semolina has become a special industry, and large establishments for this purpose have been formed, which stand in the same relation to the macaroni factories there that the flour mills here do to our bakeries. It has thus become an easy matter for the factories there to secure material ready prepared and always of just the right grade for the best macaroni.

In this country just now, in connection with the development of the macaroni industry, one of the greatest needs is for a few enterprising millers to begin this same business of specializing in the manufacture of semolina from true macaroni wheats, in response to the demand that already exists among our own factories. To make the matter a success it should be begun in direct cooperation with certain factories who would agree to take all the semolina the mills could furnish, provided it were always of the grade required. It is known to the writer that a number of factories would be glad to do this. On the other hand, with due notice of such a movement to the farmers and grain dealers, the necessary supply of excellent wheat will be forthcoming in good time; in fact, will probably be ready in sufficient amount for a good beginning after the coming year's harvest. At the same time there is probably opportunity for considerable business in the sale of miscellaneous products from these wheats, such as flour for bread making, grits for breakfast foods, etc.

Millers have usually been deterred from operating with such wheats because of the idea that it would involve too radical a change in their methods in proportion to the profits that would likely follow. It is probable, however, that the difficulties in the work are greatly overestimated. From testimony of those who have investigated the matter, it appears that the important thing is to know the nature of the semolina required. This being known, the methods of producing it are learned by practice, and may be carried out it seems, simply by the addition of moisture and slight modification or arrangement of the ordinary milling machinery used in making bread flour. Consul Skinner says concerning this matter:[1]

> The devices required for producing semoule are essentially the same as those essential to the grinding of first-class flour, the main difference being that the grinding is less fine and that moisture is introduced.

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[1] In letter already quoted.

The following statements are quoted from a paper by Mr. Edwin W. Serrell, of Paris, an authority in this line, and transmitted to this Department through the Department of State by the courtesy of Consul Covert:

> Any American grist mill fitted with modern machinery can be made to do the work if properly handled. * * * The manufacturers in America have been making inferior pastes from soft wheats, and the millers may be trying to turn out something which is not the thing wanted for paste manufacture. If they have been trying to turn out *flour* for this purpose, then it is certainly the case, for flour is not what is used for the manufacture of high-grade edible paste. * * * Unless I am very much mistaken in so far as milling is concerned, what is needed, and the only thing needed, is a definite knowledge on the part of the millers of the exact nature of the product to be turned out, and of the arrangement of their existing machinery best adapted to its production. I may add that I think only very slight changes of method would be needed in American mills to enable them to turn out what is wanted, and that such changes would be rather in the operations than in the machinery.

BREAD FROM MACARONI WHEATS.

Aside from the use of macaroni wheats in paste making, the writer is confident that a large demand is in store for these wheats in future for bread making, not only in foreign countries where they are already seeking for such wheats for bread, but in this country as well. Let the use of these wheats once become general for making pastes and the people will soon discover their excellence for bread making as well. The evidence from actual experience in favor of these wheats for bread from the standpoint of both taste and nutrition is too great to be longer ignored. On the other hand, the objection to their use in this way from the standpoint of difficulties in milling operations will soon be found to be not well taken. If they are properly handled they can be readily ground into bread flour, though in some instances it may be found advisable to mix a small percentage of hard red wheats with them. There is no good reason why the much despised "Goose" wheat of the Northwest may not yet rank well with the Fifes and Blue Stems even in the production of bread flour. At least four prominent flour mills in this country are now known by the writer to be grinding these wheats, and in absolutely every case of those so far known to the writer where bread made from the resulting flour has been used the parties now prefer it above all other kinds. It is found also that the grits made from these wheats make excellent breakfast foods.

By far the largest amount of bread flour from macaroni wheats is manufactured in the Volga River region of East Russia, the native home of the best varieties of these wheats, and it is in this region that the use of such flour for bread was first practiced on an extensive scale. Besides being one of the largest wheat regions of Russia, it is also one of the most important milling districts, and yet a large proportion of the wheat used in most of these mills is the variety Kubanka, a macaroni wheat. The mills are fitted in the most modern style with the Hungarian system of rolls, but invariably possess steaming machines for moistening and softening the grain. The bread of that region made from this wheat has become very popular, and the visit of every foreigner who is a lover of good bread increases its reputation. The famous bread of Moscow called "Kalach," as well as several excellent kinds in Odessa, are made from this wheat. There is a certain richness of flavor in such bread not found in other bread. But probably the most important quality is that it will remain palatable so long, not drying out readily nor becoming stale. The color of the flour and bread is yellowish, and indeed the preferred color of bread in east and southern Russia, and to a great extent in France, Greece, and Italy, is yellowish and not white.

It will be proper to close this topic with a few remarks on the use of macaroni wheat flour for bread in France and the possibilities of extension of our foreign markets for wheat and flour in case we should grow this kind of wheat. Quoting still further Consul Skinner's letter, he says:

> French bread to be satisfactory must be made of mixed flour, and consequently until popular taste undergoes a radical change, and irrespective of the amount of wheat grown in France, there will always be a market for a really hard wheat, in the first place to supply the requirements of semoule manufacturers, and in the second place to supply flour for mixing. What is true of France is largely true of the entire Mediterranean country, and the farther East one goes the greater is the desire for hard wheat. In Greece, for example, the bread is manufactured exclusively from hard wheat, and there is a pretense that it is more nutritious and palatable on this account. It has the further advantage of remaining fresh for a longer period, being said to be as good at the end of a week as the day after baking. Right here in Marseilles a special loaf is manufactured for sandwich purposes, and the delicate slices, I know from personal experience, remain fresh for from twelve to eighteen hours after they have been cut. My recollection is that our American bread hardens very promptly after the loaf is cut.

CULTIVATION OF MACARONI WHEATS.

In a general way the methods to be employed in the cultivation of macaroni wheats are similar to those required for the best results with any other wheats. Early plowing, thoroughness in preparation of the seed bed, early seeding, and all those other principles of prime importance in general wheat culture are perfectly applicable in the culture of these wheats. The chief thing to be kept in mind is that with macaroni wheats some of these principles need special emphasis. Since these wheats are to the farmer of special value for growing in semiarid districts, the principles needing particular emphasis are the same that are to be observed in all wheat growing in such districts.

PREPARATION OF THE SOIL.

As rapidity of growth and ripening seems to be one of the requisites for the production of a good macaroni wheat grain, these wheats are pretty generally used as spring wheats, for in districts of short hot summers the winters are usually too severe for growing winter wheats.[1] All plowing should therefore be done the previous summer, if the wheat is not to be sown on a summer fallow. The plowing should be rather deep. Then afterwards it should be lightly cultivated once or twice before winter. It is particularly important to disk lightly or harrow as soon as practicable after a heavy rain. After the alternate freezing and thawing of the winter and further spring cultivation, the ground will be in excellent condition for seeding. Seeding should be done as early as possible, just as soon as the ground can be put in good condition after the frost is out. Early seeding will promote early ripening.

METHODS OF SEEDING.

All the tillage of the ground after the original plowing, up to the time of seeding, should be such that only the portion near the surface is cultivated, while the portion below remains compact and in condition to hold as much moisture as possible. All experience in wheat culture is so full of evidence in favor of the use of the drill, that it is hardly necessary to say that seeding should be done with that machine. There is special reason, however, for seeding only with the drill in growing these wheats in semiarid districts, and not only that but for the use of a particular kind of drill. It must be remembered that we are preparing to resist drought—possibly intense drought—and while we are using drought-resistant wheats, which will make all the better grain, too, because of the drought, yet in order to make a crop at all we should aid the wheat by taking all the steps possible to conserve and utilize the little moisture that falls. A drill should therefore be used which is a sort of combination of the press and lister drills. That is, in addition to the listed furrow, the grain should be put down still deeper, and the soil compacted around it as in case of the press drills. Then the depth of the furrow and the fine dirt rolling in from above will combine to protect the moist earth below from evaporation, and at the same time the dry south winds will not be able to blow the dirt away from the roots or what is worse blow the wheat itself out of the ground. The rate of seeding per acre should be about the same as with other wheats. These wheats do not stool as much as ordinary wheats, but produce all the better heads by not doing so.

CARE IN HARVESTING.

It is important for producing a perfect quality of grain that macaroni wheats should be harvested at just the right time. They should be entirely ripe, and harvesting should not be done in damp or even cloudy weather, if it can be avoided. The brighter the sunshine and

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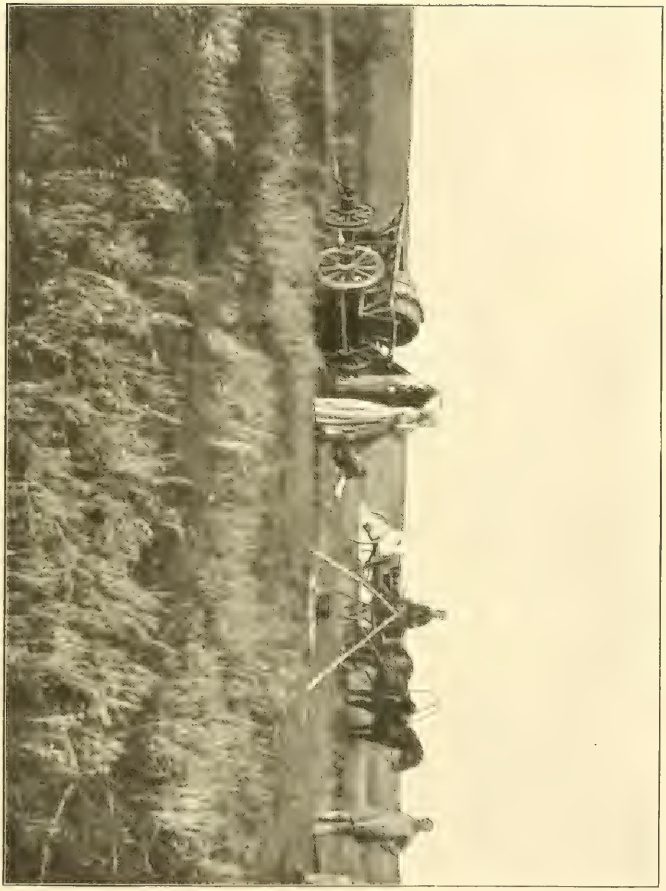
[1] These may be grown as winter wheats, however, as far north as southern Kansas.

PLATE VII.



CAMP OF KIRGHIZ HARVESTERS NEAR URALSK, ON THE SIBERIAN BORDER; A TWO-HORSE RUSSIAN VEHICLE FROM THE CITY IN VIEW.

drier the air the better. In east Russia the peasant farmers (Pl. VII) even go so far as to practice reaping only at certain hours in the hottest part of the day, claiming that the quality of the grain is made more perfect in that way.

EFFECTS OF LOCAL VARIATIONS IN SOIL AND CLIMATE.

All macaroni wheats are extremely sensitive to changes of soil and climate. This fact will account for certain peculiarities in the quality of the grain that have already been noticed by growers occasionally in this country. Samples are now and then received by this Department in which the grains are partially soft and white. These are from crops grown either under damper, cooler conditions, or in places where there is comparatively little nitrogen in the soil. The requisite conditions for a perfect grain are a *black prairie soil* and *short, hot, dry summers*. On the whole, changes of climate appear to have a greater effect than changes of soil, but if the soil becomes almost bereft of humus the grain shows the effect plainly by becoming more opaque and white, because of the preponderance of starch. If in this case the climate is at the same time arid, the grain remains rather hard, but simply because of its dryness. If the soil is black and rich and the climate too moist, there is considerable discoloration and black ends (mouchetés) may show themselves. Two or three good rains are sufficient to mature a crop. Otherwise, the drier and hotter the better, while a humid atmosphere can not be tolerated.

VARIETIES.

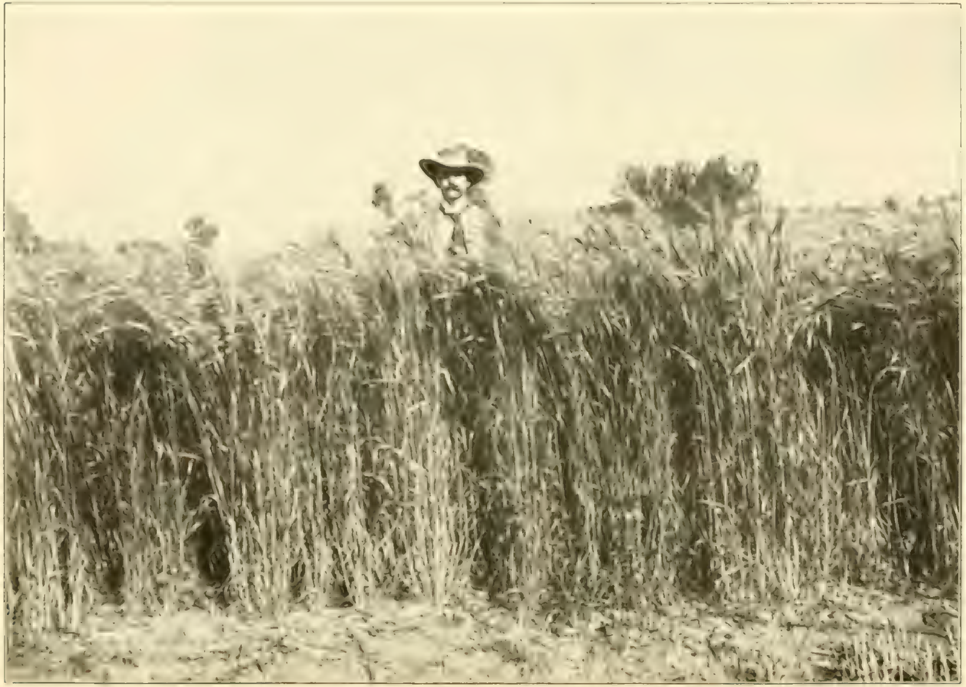
From 50 to 75 so-called varieties of durum or macaroni wheats have been described by different writers. If we include with these a number of others that have not been mentioned in print, there are probably a hundred or more varieties already known to be in use under distinct names. A very critical study would be necessary to determine how many of these are identical with each other. Durum wheats of nearly a hundred different descriptions are now under experiment by this Department, and many more will be added before the end of this year. Though the larger number of varieties are, in practical use, of minor importance, there are a few having well-marked characteristics, and which have attained a high reputation. As some of these varieties are likely to furnish the larger part of the entire macaroni wheat production of this country for a number of years at least, it will be advisable to describe them briefly here.

GHARNOVKA.

The variety which is the basis of a very large part of the macaroni wheat export from the Azov Sea region is the Gharnovka. Considerable confusion exists concerning the names of these Russian macaroni varieties, and even the statements of grain experts occasionally conflict with each other. But it is certain that the name Gharnovka is most generally applied to the usual variety grown throughout this region. The wheat itself has a medium long, square, dense, yellowish-white head, while the beards are dark and very long. The grain is quite large, light yellow in color, and rather translucent and vitreous. There are several different strains even of the Gharnovka recognized in the Don territory. Probably the best of these is the Yellow Gharnovka, which has a grain of a deeper yellow than the others. The best quality of Gharnovka seems to be grown in the district between Kerch and Berdiansk. A good quality is occasionally obtained also in the Eisk district just southeast of Rostov-on-Don. Both the Gharnovka and Yellow Gharnovka have recently been obtained and distributed by this Department. This wheat is admirably adapted to such districts as Kansas, Nebraska, Oklahoma, and eastern Colorado. It will probably prove to be one of the best durum wheats for the middle and southern Great Plains, as well as for New Mexico and Arizona. Gharnovka is being grown this season by the New Mexico Agricultural Experiment Station, and so far gives promise of excellent results. A photograph of the wheat in the field (Pl. VIII) is kindly furnished by Prof. J. J. Vernon .

ARNAUTKA.

The two terms by which Russian macaroni wheats are usually known outside of that country are Taganrog and Arnautka. The former term is entirely meaningless. It does not correctly designate a special variety at all, but may refer to any wheat in east or south Russia, even to wheats that are not of the durum group. Arnautka is properly the name of a special variety, but is also often applied in a too general way. It is apparently not grown to so great an extent as Gharnovka, but it is nevertheless one of the best varieties of south Russia. So far as the writer can determine, what is properly called Arnautka is a wheat having heads of a light red color, with a bluish bloom and very long reddish beards. The grains are very large and long, and when grown under favorable conditions are a clear yellow, extremely hard and vitreous. This and Gharnovka are the two varieties which have given Russia its reputation for macaroni wheats, although one or two other Russian sorts are probably even better than these for making that product. Arnautka is the name always most familiar to Americans in speaking of these wheats. It was one of the first durum wheats to be introduced into the United States. The first importation was made by this Department in 1864, but the possibility of its future use with us as a macaroni wheat was then never thought of, it seems. It was grown occasionally for many years afterwards, but meeting with much opposition its cultivation was finally abandoned. The



Gharnovka Wheat at the New Mexico Experiment Station

variety has, however, been imported occasionally for seed up to the present time. The writer has so far seen nothing but the grain of the variety now grown considerably by the farmers of North and South Dakota under the name Arnautka, and can not say whether it is the same as that above described or not. This variety is well adapted for cultivation in Kansas, Colorado, Oklahoma, and Texas.

KUBANKA.

This is a well-known and plainly distinguished variety (Pl. I, *1*) grown chiefly in east Russia, and from all standpoints is one of the two or three best Russian macaroni wheats. It has been twice imported by this Department in the last two years, and distributed chiefly to the State experiment stations. In districts where it is adapted its trial has already been followed by remarkable results, much beyond the expectations of the writer, who knew it to be the best wheat on the Siberian border. It is one of the most drought-resistant varieties known in east Russia, and produces a grain of excellent quality. It has medium or short heads, that are white with occasionally a slight bluish bloom, and have rather long beards. The grain is large, yellowish white, and very hard. The variety is much grown by the Kirghiz and Turghai people on the Siberian border (Pl. IX, fig. 1), where it is absolutely impossible to grow ordinary wheats of any kind because of the extreme drought, the rainfall being as low as 10 inches per annum. On being grown in the northern Great Plains it has uniformly given yields better than those of other wheats, and in the more arid portions has yielded 2 to 4 times as much. In the Dakotas it ripens in good time, and in Nebraska is much earlier than other wheats. At Arapahoe, Nebr., it matured in 76 days from seeding. It is constantly resistant to all diseases wherever tried in this country. This variety takes its name from the Kuban territory. It is cultivated throughout the entire Volga River region from Kazan to the Caspian Sea, and eastward into the Kirghiz Steppes and Turkestan. It is the most popular bread wheat of the lower Volga region (Pl. IX, fig. 2.) At Saratov and Tsaritsyn a very large amount of it is ground into bread flour, but is usually mixed with 10 to 20 per cent of red wheat in grinding. The flour is always yellow, and makes a yellowish bread with a rich brown crust. Kubanka is particularly adapted for our northern Great Plains as far south as Kansas, but might be grown as a winter wheat still farther south.

PEREKODKA.

This is properly but a special strain of the variety Kubanka supposed to have been evolved through the influence of changes of soil and climate, particularly the former. Though considered in east Russia to be in general rather inferior to Kubanka, it has in certain respects given better results than the latter in this country. In North Dakota it yielded better, and in South Dakota the grain was discolored less than that of Kubanka. It yielded considerably more to the acre in North Dakota than the Fife and Blue Stem. The grain is darker colored originally than that of Kubanka; otherwise they are practically the same.

BELOTURKA.

The variety Beloturka is very similar to Kubanka, but differs from it in having a longer, narrower head, and longer grain which is not so thick. Like Kubanka it is also extremely drought resistant. It is grown throughout the Volga region, but especially in southeast Russia. The name means "White Turkish." It is well known to be very resistant to rust in all countries, but has been especially well tested in this regard in Australia. Its value in this respect has been conclusively shown in all experiments by this Department. Beloturka and Medeah are the two varieties particularly recommended for rust resistance in hot coast districts by the Australian Rust-in-wheat Conference of 1892. The bright yellow grain is of the very best quality. It is probable that if there were a better knowledge of varieties among the macaroni wheat dealers of France and Italy, it would be noted that this variety and Kubanka are really of better quality than the varieties Arnautka and Gharnovka, which have obtained their reputation partly by the mere association of being grown near Taganrog; and as before stated all the wheat, Gharnovka, Kubanka, or otherwise, goes to Mediterranean ports as simply Taganrog wheat. Beloturka is also adapted for growing in the northern Great Plains especially.

VELVET DON.

This variety, called Chernouska in Russia (Pl. I, *3*), has heads of medium length, rather thick, always with velvet chaff and long black beards. There are usually brown spots on the chaff throughout the length of the head. The grains are quite large, very hard, and darker in color than in the varieties just described. It is grown to a considerable extent in the Crimea and near Sarepta in the Volga River region. Mr. Nekludov, superintendent of the large Mikhalkov estate at Ambrocievka, Don territory, says that under the general term Arnovka (probably the same as Arnautka) are included Gharnovka, Yellow Gharnovka, and this variety. He also considers Yellow Gharnovka to be the best variety in that region, and Chernouska or Velvet Don to be the next best. (See fig. 2.) Velvet Don has been imported by the Department, and is now being grown by several of the State experiment stations. This variety is well adapted for growing in any portion of our semiarid districts, but may prove to be specially fitted for use as

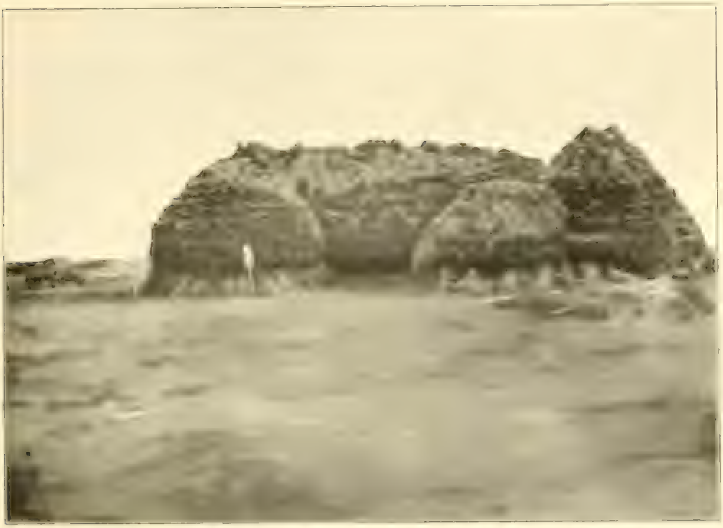


FIG. 1.—[illegible]

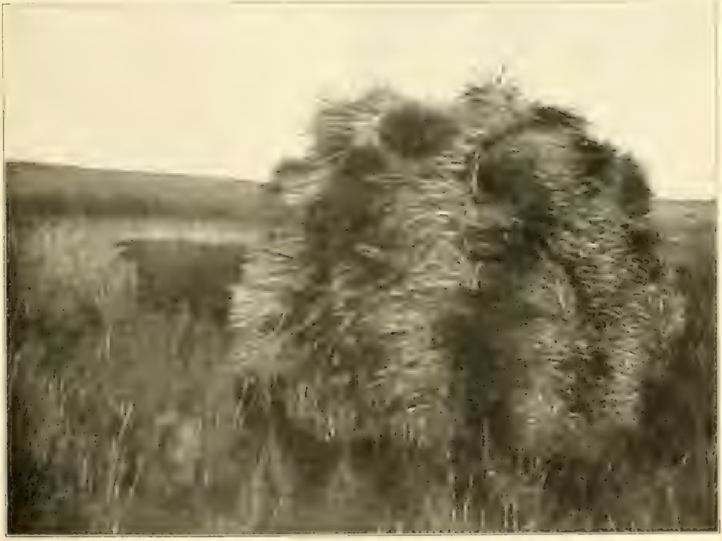


FIG. 2.—[illegible] RIVER REGION.

a winter wheat in Texas. It is very drought-resistant and ought to be quite resistant to leaf rust.[1]

BLACK DON.

Black Don (Pl. I, *4*) is known as Chernokoloska in Russia, and is grown a great deal in the Don territory, as well as throughout the Volga region, and to some extent in the Crimea and in Siberia. The variety is characterized by heads of medium length with black chaff, having a bluish-white bloom and long black beards, and light yellow, very hard translucent grains of medium or large size. The appearance of the grains is similar to that of Gharnovka, though the quality is probably not quite so good. The best quality of this variety seems to be grown in the district near Sarepta, in the Volga River region. When grown from well-selected seed its appearance in the field is very striking, because of the black heads. This variety has also been imported by this Department and distributed in several of the States of the semi-arid districts. It is well adapted for any portion of these districts, but may be especially suitable for a winter variety in Texas.

Fig. 2.—Cleaning Velvet Don wheat on the estate of Mr. Mikhalkov, in Don Territory.

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[1] On the other hand, in unusually damp, cloudy seasons all these macaroni wheats are likely to be severely affected by the black stem rust. In the Don territory, near Taganrog, some fields were almost ruined by that rust in 1900, as observed by the writer.

SARUI-BUGDA.

A variety known by this Tartar name and which is apparently distinct but may be closely allied to Beloturka or Arnautka, is grown considerably in North Caucasus, near the Caspian Sea, but especially in Turkestan. It is probably one of the most drought-resistant wheats known anywhere, being the chief durum variety of the arid region of Turkestan. It no doubt also resists extremely the injurious effects of strongly alkaline soils. The grain is very large, yellowish white, extremely hard, vitreous, and translucent. Heads of the wheat as grown in Turkestan have not been seen by the writer, but from descriptions they are in every way similar to Beloturka, except a tinge of red in the chaff. So far as known to the writer, it has never been shipped in quantity for making macaroni, so that its value for that purpose is not known. It is of special value to us at present, because of its superior drought resistance, but may be found to be excellent for macaroni as well. The best quality of grain so far seen by the writer came from the Lenkoran district on the Caspian Sea.

In 1899 Prof. N. E. Hansen obtained for the Department a durum wheat numbered 1174, Section of Seed and Plant Introduction, which came originally from Turkestan, and which appears to be equivalent to Sarui-bugda, but which may prove to be distinct. A difficulty in studying it (1174) arises from the fact that it is badly mixed with another variety; but when grown in this country the part of the crop resulting, which is true durum, is very vigorous, extremely hardy, and of fine appearance in head and grain. It was distributed rather widely, and the results in semiarid districts have been uniformly good.[1] This and Sarui-bugda are admirably suited for growing in the driest portions of the Great Plains, where anything can be grown at all.

MEDEAH.

The variety Medeah (Pl. II, *2*) has of all wheats attained the greatest reputation for rust resistance.[2] It is mentioned oftener than any other in discussions of that subject, but it is especially recommended in Australia[3] and Cape Colony[4] as a result of investigations with rust in those countries. In the conclusions of the several rust-in-wheat conferences in Australia, this variety was recommended along with Beloturka as being the best for the hot coast districts. It has been much employed by William Farrer, a wheat expert of New South Wales, in hybridizing with other varieties in order to introduce the same quality of rust resistance into ordinary bread wheats. In experiments made by this Department it has been found to maintain consistently its reputation in this regard in this country also.[1] It is a well-known Algerian variety, having medium-sized brown or black heads, with a bluish bloom to the chaff, and black beards, and yellowish, hard grains. It is similar to Black Don in general appearance. Aside from its rust resistance, Medeah has a good reputation for drought resistance and yield in many countries. It is especially well adapted to our middle and southern great plains, particularly in Texas.

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[1] The selected durum portion of 1174 has been separated and numbered 1548 in the cereal investigations of the Department. The other portion, which is a bread wheat and is numbered 1550, may prove also to be of great value in further experiments on account of its earliness in ripening.

[2] Probably referring to orange leaf rust in nearly all cases, however. This point is difficult to determine, since there are so few cases of reported rust resistance in which it is stated definitely which rust is meant.

[3] See report of Australian Rust-in-Wheat Conference for 1892, p. 71; also various articles in Agricultural Gazette, New South Wales.

[4] See numerous short articles in Agricultural Journal of Cape Colony, and especially Vol. XV, pp. 229-235, August 17, 1899.

PELLISSIER.

This is a much-praised, selected variety, bred in Algeria. It seems at present to be one of the best of the Algerian varieties, and will probably be a valuable variety for our southern great plains. M. Henri Vagnon, at Kherba, Clos des Bras, Algeria, has grown El Safra, Nab-el-bel, and several of the other best varieties, along with Pellissier, in that part of Algeria, and as a result of his experiments highly recommends the latter.[2] Seed of these varieties was obtained by the Department from M. Vagnon in 1896, and the varieties have been grown in Kansas in experiments to determine rust resistance. Pellissier not only proved to be quite rust resistant, but appeared to be a good, hardy wheat in other respects.

CANDEAL.

This variety is the principal durum wheat of Argentina and Chile, having been introduced there originally from Spain. It has heads of medium size, with white smooth chaff and rather long white beards. The grains are rather large and light yellow. Practically all the wheat furnished to France and Italy from South America for macaroni, which has come to be considerable in recent years, is of this variety. It has been tested for rust resistance in field experiments made by this Department and found to be very good in that respect. Its drought resistance and quality of grain in this country is yet uncertain. It is adapted for cultivation in our middle and southern Great Plains region.

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[1] Cereal rusts of the United States, Bul. 16, Div. Veg. Phys. and Path., pp. 23–40, September 27, 1899.

[2] See "Culture Rationnelle des Céréales en Algérie," Jour. d'Agric. Pratique, 59e, Tome I, pp. 494–498, 1895. In this report M. Vagnon names Pellissier, El Safra, and Volo as the best three in his experiments, placing Pellissier as first.

NICARAGUA.

Until recently probably no one of the durum wheats has attracted so much attention in this country as Nicaragua, and it is practically the only wheat of this group yet known in the southern United States. Its origin is not known to a certainty, though the name would indicate that it came from Nicaragua, and the wheat almost entirely grown in Nicaragua is of the same group as this variety. The real Nicaragua wheat has recently been received by the Department from Mr. I. A. Manning, United States consular agent at Matagalpa, Nicaragua, and its appearance is in all respects like this variety, so far as the grain is concerned. From various reports it appears that Nicaragua has been grown in Texas nearly twenty-five years.

Mr. James J. M. Smith, whose letters have already been quoted, states in his letter of May 29, 1898, that—

> In 1878 I found this wheat growing abundantly in Burnet, Williamson, Bell, Travis, Lampasas, Llano, and San Saba counties. I learn also that it was raised extensively all over this section of Texas.

Almost invariably it has given excellent yields, far above that of any other wheat, including the popular Mediterranean. It has apparently made average yields of from 20 to 30 bushels per acre, and quite often yields 40 to 50 bushels per acre. Its cultivation has always been chiefly in Texas, but it is grown occasionally also in South Carolina, Georgia, Arkansas, Louisiana, and other Southern States. It first became popular almost wholly on account of its rust resistance, but has since been found to be excellent for late fall pasturage.

Nicaragua wheat has rather long, narrow heads, with white or yellowish-white chaff and rather long beards, and a large, deep yellow, hard grain, when grown under favorable conditions. When sown in the autumn, as it often is in central and northern Texas, it makes a rank, vigorous growth and furnishes abundant winter pasturage. It is said to reach a height of 5 or more feet.

This variety to give best results in quality of grain should be grown farther west in Texas than it is now grown. As grown in the region from Wichita Falls and Abilene it ought to be of excellent quality for macaroni.

WILD GOOSE.

This variety is grown to a considerable extent in North and South Dakota, but on a much larger scale in Canada. It is related that a hunter found a few grains of wheat in the crop of a wild goose that he had killed, the grains were planted and grew, and the present variety has its origin in these few grains, and takes its name from the incident. Even if this story is true, the original grains must of course have been obtained by the bird from some farm in the Northwest, and as the Russian farmers of the Northwest have occasionally imported seed of durum wheats from Russia for many years, it is very probable that this variety is equivalent to one of the South Russian macaroni varieties. This and the preceding are the only macaroni wheats that have so far become pretty well established in this country.

Wild Goose has a white chaff, heads somewhat similar to Kubanka, and rather long beards. The heads are shorter and proportionally thicker than those of Nicaragua. The grains are quite large, light yellow in color, and very hard and translucent in the best grades of the wheat. A considerable amount of this variety has already been exported from Canada to France and Italy for making macaroni, and is reported to be in some instances equal to the Taganrog wheat for that purpose; and yet the wheat as grown in Canada is probably inferior to wheat of the same variety as grown in the Dakotas.

MISSOGEN.

Almost the entire wheat production of Greece is from the durum group. Bread there is commonly made from these wheats. There are a number of important well-known varieties grown, such as Missogen, Atalanti, Volo, etc. Missogen (Pl. II, *5*) is one of the best and is fairly representative. It has a medium or short head, rather thick and flattened, and with white, or reddish-white, chaff and beards of medium length. The grains are quite large, yellow or light brown, and very hard. In experiments of this Department it has proved to be extremely rust resistant with respect to orange leaf rust, and appears to be generally rather hardy.

POLISH.

This wheat, which belongs to a group entirely distinct from the true durum wheats, is already referred to and described on page 11. It may also be used in making various edible pastes, and possesses besides several other valuable qualities. It is very resistant to drought and leaf rust, and never was known by the writer to be affected with bunt or smut. Its yield in semiarid districts compared with other sorts is always good. As already mentioned, this wheat in 1894 yielded 24 bushels per acre without irrigation at Garden City, Kans., some distance west of the one hundredth meridian. Polish wheat was introduced from south Russia two years ago by this Department, and on being tried at several stations has yielded well in semiarid localities. It is adapted for growing in any part of the semiarid Great Plains.

WINTER VARIETIES.

Macaroni wheats are as a rule to be considered as spring varieties. Nicaragua, however, is very often sown in the autumn in Texas, and is said to give much better results when sown in that season. Other sorts when taken below the thirty-fifth parallel could no doubt also be transformed into good winter varieties by gradually increasing the earliness of spring sowing until they are practically sown in autumn. The wheat is thereby not only made more vigorous by its autumn root growth, but is also likely to yield more and furnish an abundant supply of early winter pasturage; for these wheats always make a vigorous growth at once after they come up.

EXPERIMENTAL COMPARISON OF VARIETIES.

As already noted, nearly all these macaroni varieties have been under experiment by this Department more or less at different times, testing their resistance to rust and drought, and in some cases their yields. Chemical analyses have also been made of many of them by courtesy of the Bureau of Chemistry of this Department and the results furnished to this Bureau for publication. Certain data from all these sources are here arranged in tabular form, for the most important varieties of macaroni wheat, as follows:

TABLE V.—*A résumé of the chief characteristics of the principal macaroni wheats as known at present.*

Name of variety.	Where grown.	Winter or spring.	Character of young plant.		Rust resistance (leaf rust).	Character of the head.			Character of the grain.					
			Color.	Manner of growth.		Form.	Chaff.	Beard.	Size.	Color.	Albuminoids.	Starch	Moist gluten.	Dry gluten.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Black Don	Russia	do	Very light green.	do	85	Average	Black	Black	do	Light yellow.	e15.75 f14.19	...... f69.74	e41.00 f33.58	e14.68 f13.02
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Kubanka	do	do	Very light green.	do	(a)	Short	White	White	do	Yellowish	[illegible] i12.88 [illegible]	...... i62.48 [illegible]	[illegible] i36.61 [illegible]	[illegible] i13.63 [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Missogen	Wales. Greece	Spring or winter.	......	do	(a)	Thick	Red	Reddish	do	Light yellow.	16.63	......	37.92	11.22
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pererodka	Russia	Spring	Very light green	do	......	Average or large. Average or short	White	White	......	......	16.00	52.13	39.80	14.39
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Velvet Don	do	do	do	do	96	Thick	Velvet, reddish.	Black	do	Yellowish brown.	e15.21 f14.44	...... f59.70	e38.22 f34.72	e11.10 f13.21
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Wild Goose	Canada	Spring	do	do	(a)	Average	White	White	do	Yellowish	13.48	......	32.56	13.09
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

a Almost rust free. The figures give actual per cent of resistance.
b Sample from Kharkov.
[illegible]

[illegible]

j sample from Orenburg.

As will be seen by the table, macaroni wheats almost always are light green in color in the first stage of their growth, while ordinary wheats are a darker green. There is also rapid growth at this stage; the leaves are usually large and the plants grow erect, thus affording the abundant pasturage for which fall-sown varieties are noted. As to chemical composition, nearly all varieties here presented are uniformly high in gluten content and the percentage of albuminoids. Ordinary bread wheats are considered to have an unusual gluten content if it reaches 11 or 12 per cent dry gluten, but it is not especially unusual for these wheats to have 13 and 14 per cent. On the whole, Russian varieties have invariably a higher per cent of gluten and protein than those of other countries. In confirmation of the expectation of the writer, it is seen that the Arnautka from North Dakota compares well with the best varieties direct from Russia in protein and gluten content. It is, however, a Russian variety originally, and when grown in North Dakota, simply finds very similar conditions to what it has previously been used to. The superiority of Russian varieties, already shown by their greater demand as well as their higher protein content, and also the excellent quality of durum wheat, when grown on our Great Plains, is almost certainly due to the unusual humus content of the soils of the Russian and American regions, respectively, which has already been discussed. The proper climate is a feature probably of greater importance, but a considerable amount of soil humus is absolutely essential. In harmony with this thought it is to be expected that Algerian or Argentine varieties will improve on being grown on our Great Plains, while Russian varieties will probably deteriorate when grown in Arizona or New Mexico. But Russian sorts grown in the region from North Dakota to west Kansas, or possibly to the Texas Panhandle, will be the very best.

There seems to be something more than the simple amount of gluten that gives macaroni wheats a superiority over bread wheats for making macaroni, since often bread wheats having the same gluten content do not apparently make as good macaroni. Nevertheless, gluten content is evidently important, and, besides, the unusual protein content of such wheats is of great importance from the standpoint of nutrition.

RUSSO-MEDITERRANEAN TRAFFIC IN MACARONI WHEAT.

In making up statistics of wheat production and export separate figures are never given for durum wheats, even in Russia, where such wheats are so important. It is therefore only possible to obtain an approximate idea of the export of these wheats from Russia to the western Mediterranean region. It is known to be quite extensive, however, in proportion to the amount of other wheats exported from that country. The Section of Foreign Markets of this Department has kindly furnished data giving the entire wheat export of Russia

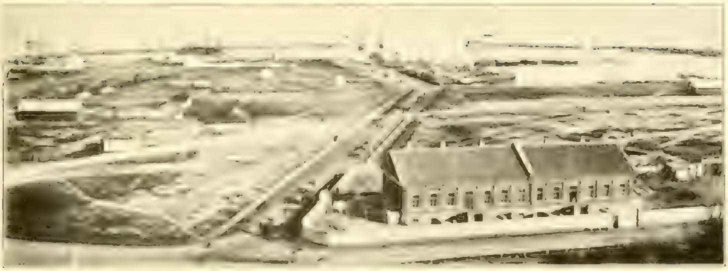
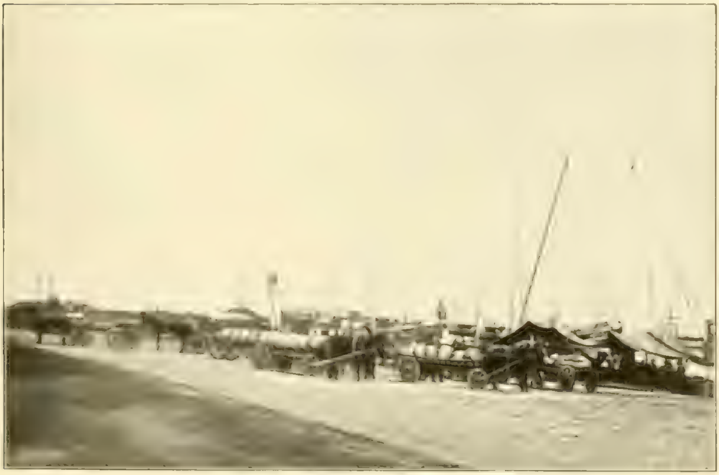


FIG. 1.—PORT OF TAGANROG, RUSSIA, THE LARGEST PORT FOR THE EXPORT OF MACARONI WHEAT [illegible]



F[illegible] 2. [illegible]VKA (MACARONI) WHEAT ONTO THE STEAMER IN BULK AT TAGANROG, TO BE SHIPPED TO MEDITERRANEAN PORTS.

for the years 1894–1898, inclusive, and her export to France and Italy for the same period. The entire export averages 126,677,079 bushels. The average export to France is 19,892,517 bushels (including spelt and maslin[1]), and the export to Italy averages 21,204,469 bushels. It is known that a considerable quantity of the export to Italy is soft wheat. In other data giving imports into France and Italy from Russia, also furnished by this section, it is definitely stated that in 1899 6,274,129 bushels of the import into Italy was soft wheat; that is, considerably more than one-third of the entire amount for that year, which was 15,400,153 bushels. It is pretty certain that the proportion of soft wheat shipped to France from Russia is much less, probably not more than one-fifth. The entire wheat export to both France and Italy is 41,096,986 bushels. It is probable that the soft wheat, spelt, maslin, etc., would altogether make up no more than one-third of this amount. To be safe in statements, however, the proportion of macaroni wheat shipped from Russia to these two countries may best be given, not as two-thirds of the entire amount, but as about 20,000,000 bushels. But certainly not more than four-fifths of the Russian Mediterranean export of this wheat goes to France and Italy. Adding, therefore, 5,000,000 more for the other countries on the Mediterranean we have what is surely a conservative estimate of 25,000,000 bushels as representing Russian export of this class of wheat into the Mediterranean region. The Russian trade in these wheats is far greater than Americans realize. In fact, many do not realize that there is such a trade at all. The writer is rather confident that the entire annual Russian export of durum wheat to all countries does not fall far short of 40,000,000 bushels. It must be remembered, too, that in the markets where this wheat goes no other wheat can be substituted. To compete with Russia in these markets we must therefore raise macaroni wheats. If we should succeed in securing only half the market it would mean an addition of 20,000,000 bushels to our export trade. It should be noted that international freight rates on grain exported from this country appear to be about the same as for Russia and the oriental countries.

The steamers engaged in the Russian export trade with this wheat belong to several different lines, the best known of which is probably the Russian Society of Commerce and Navigation. This is the most important steamship line in south Russia, has excellent harbors, and touches at all points on the Black and Azov seas. The principal points from which durum wheats are shipped are Taganrog (Pl. X, figs. 1 and 2) and Berdiansk, but large quantities are shipped also from Rostov-on-Don, Novorossisk, Theodosia, Kerch, Mariopol, and Nikolaev. Four or five trunk lines of railway (at least two of which are doubled tracked) bring most of the wheat that is grown at a distance to these points. Much the larger part of this wheat from a distance comes from the region about Uralsk and Orenburg. (Pl. XI, fig. 1.) At Taganrog and Berdiansk a large portion of the wheat shipped is macaroni wheat. A great deal of it is grown in the surrounding region. The wheat begins to arrive in greatest quantities in September. (Pl. XI, fig. 2.)

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[1] Maslin is a mixture of several grains, as rye, barley, and wheat.

SUMMARY.

(1) Macaroni or durum wheats have been occasionally grown in this country for many years, but the absence of a known market has heretofore prevented their extensive cultivation.

(2) In connection with its seed and plant introduction work the Department has been making special effort during the past three years to stimulate an interest in American-grown wheat of this class. As a result of this movement, and with the aid of private parties interested, the following progress has already been made:

(*a*) All macaroni wheat of good quality that will be produced this present season (which will probably amount to over 75,000 bushels) is now practically contracted for at a good price.

(*b*) A majority of our own macaroni factories desire to use semolina of durum wheats grown in the United States, and from some of them there is now an urgent demand for it, but it can not be obtained.

(*c*) Samples of our macaroni wheats sent to French manufacturers of semolina have been tested and reported to be as good as wheat from Taganrog, Russia, though it is known that a much better wheat is now grown in North and South Dakota than the samples that were sent.

(*d*) Semolina manufacturers in France and Italy have only recently discovered the excellent quality of our macaroni wheat, and now they are demanding large quantities just as soon as it can be furnished. Six or eight million bushels, if we could furnish it, would no doubt now find immediate sale at Marseilles and in Italy.

(3) In connection with these facts it may be noted that since March 1, 1901, three and one-third million bushels of Wild Goose wheat were shipped from Canada to Marseilles, and yet the Canadian wheat is somewhat inferior, as a rule, to wheat of the same class grown in North and South Dakota.

(4) A careful investigation of the conditions of soil and climate in east and south Russia in comparison with those of our Great Plains shows an interesting and remarkable similarity between the two regions. As the very best macaroni wheat is produced in large quantities in this Russian region one naturally infers that the cultivation of such wheat in the Great Plains would be attended with good results.

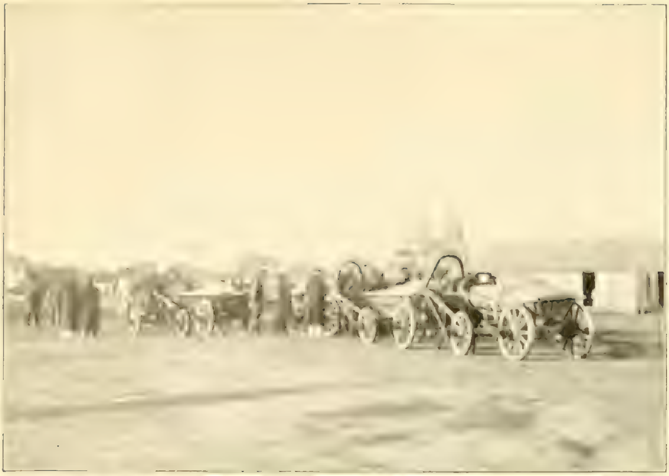

Fig. 1.—Kubanka Wheat Brought to Market by the Kirghiz Farmers, at Uralsk, on the Siberian Border.

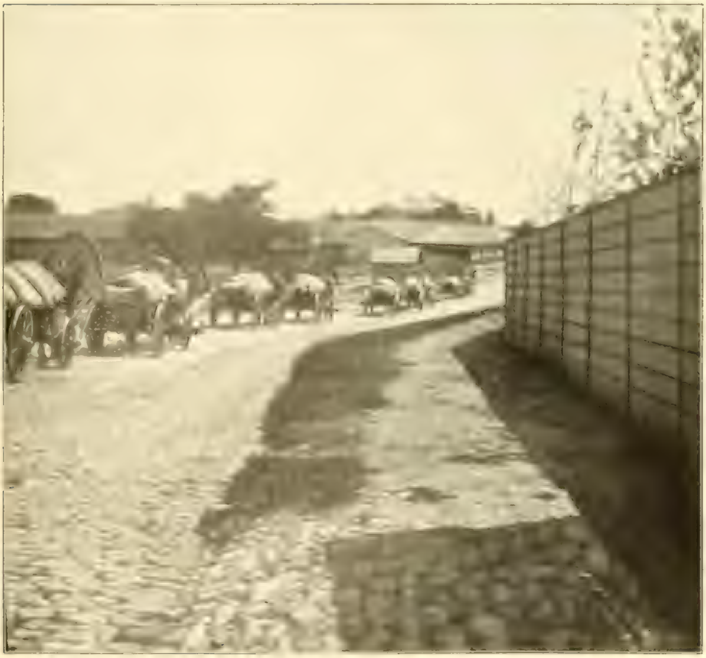

Fig. 2.—Carting Macaroni Wheat to the Wharves at Taganrog, to be shipped to Mediterranean Ports.

(5) The results of adaptation experiments made by this Department in cooperation with State experiment stations, as well as trials made by private parties, have strongly confirmed the conclusion drawn from a study of the soil and climatic conditions. The principal facts shown by these experiments are as follows:

(*a*) Macaroni wheats are extremely resistant to heat and drought.

(*b*) They are also very resistant to the attacks of leaf rust, smuts, and other parasites.

(*c*) They give the best results in the Great Plains near the one hundredth meridian.

(*d*) In many places west of the one hundredth meridian where wheat growing is now practically impossible because of drought macaroni wheats will yield ordinarily 12 to 20 bushels per acre.

(*e*) In semiarid districts macaroni wheats will yield an average of about one-third more per acre than the standard wheats usually grown there.

(6) Macaroni manufacturers do not, as a rule, grind their own wheat, but must be furnished with semolina by millers of that product.

(7) There is now a distinct demand for one or more enterprising millers in this country to arrange for specializing in the manufacture of semolina from durum wheats for our macaroni factories.

(8) Macaroni wheats can be readily ground at our ordinary flour mills by a slight rearrangement of machinery, using more moisture, and with a proper understanding on the part of the miller of the nature of the product to be furnished to the factories. The miller or manufacturer of semolina should stand in the same relation to the macaroni manufacturer that the miller of bread flour does to the baker.

(9) Nearly all our own macaroni factories are at present using flour made either from Kansas hard winter wheat or from the hard spring wheats.

(10) The superior value of durum wheats for making macaroni lies chiefly in the quantity and quality of their gluten, but possibly also in the amount and nature of certain other constituents.

(11) Macaroni when well made from our hardest bread wheats is sometimes difficult to distinguish from macaroni made from durum wheats. Almost always a difference exists, however, in favor of the product from durum wheat. The latter is usually (a) more yellowish in color, (b) more vitreous in fracture, (c) preserves its form longer in boiling, and (d) is more elastic and not sticky when served.

(12) Though macaroni wheats are usually considered to be adapted only for making macaroni, it is an idea entirely erroneous that they do not make good bread. But in grinding for bread 10 to 20 per cent of red wheat might, often with advantage, be mixed with them.

(13) In all instances in this country within the writer's knowledge

where these wheats have been used for bread the parties so using them have preferred the bread above all other kinds.

(14) The most popular bread flour in the Volga River region of Russia is made from Kubanka, a macaroni wheat.

(15) The French people, who are the greatest bread eaters in the world, prefer always a mixture of durum wheat in making their bread flour.

(16) Bread made from macaroni wheats is richer to the taste and remains fresh much longer than bread made from other wheat.

(17) Macaroni wheats furnish an excellent quality of grits for breakfast foods.

(18) In the cultivation of macaroni wheats all means possible should be employed for the conservation of moisture if they are to be grown where the rainfall is very small. They are drought resistant, but they must have the aid of proper cultivation.

(19) In all places north of the thirty-eighth parallel they should be sown in the spring, and the plowing may be done the previous summer. South of this parallel they should be sown in late autumn.

(20) In the South when sown in the autumn these wheats furnish excellent winter pasturage, usually, too, without greatly diminishing the following crop of grain.

(21) The best macaroni wheats in all respects are of Russian origin. The results of chemical analyses show that Russian varieties contain nearly 50 per cent more gluten than varieties from other foreign countries. Moreover, they are, as a rule, best adapted to the conditions of our semiarid districts.

(22) The best of the Russian varieties, and those which are best adapted to our middle and northern Great Plains, are the following: Kubanka (or Pererodka), Yellow Gharnovka, Gharnovka, Black Don, Beloturka, Sarui-bugda, Velvet Don.

(23) Some of the best varieties from other countries and adapted to the region of this country south of the thirty-fifth parallel are as follows: Nicaragua, Missogen, Medeah, Volo, Pellissier, Atalanti, Candeal, El Safra.

(24) The Russian export of macaroni wheats to the Mediterranean region is probably at least 25,000,000 bushels annually, and is an indication of the export trade with these wheats that we might secure (in part, at least) if we would grow them; for international freight rates are about the same for us to the Mediterranean region as for Russia.

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